The Healthcare Environment

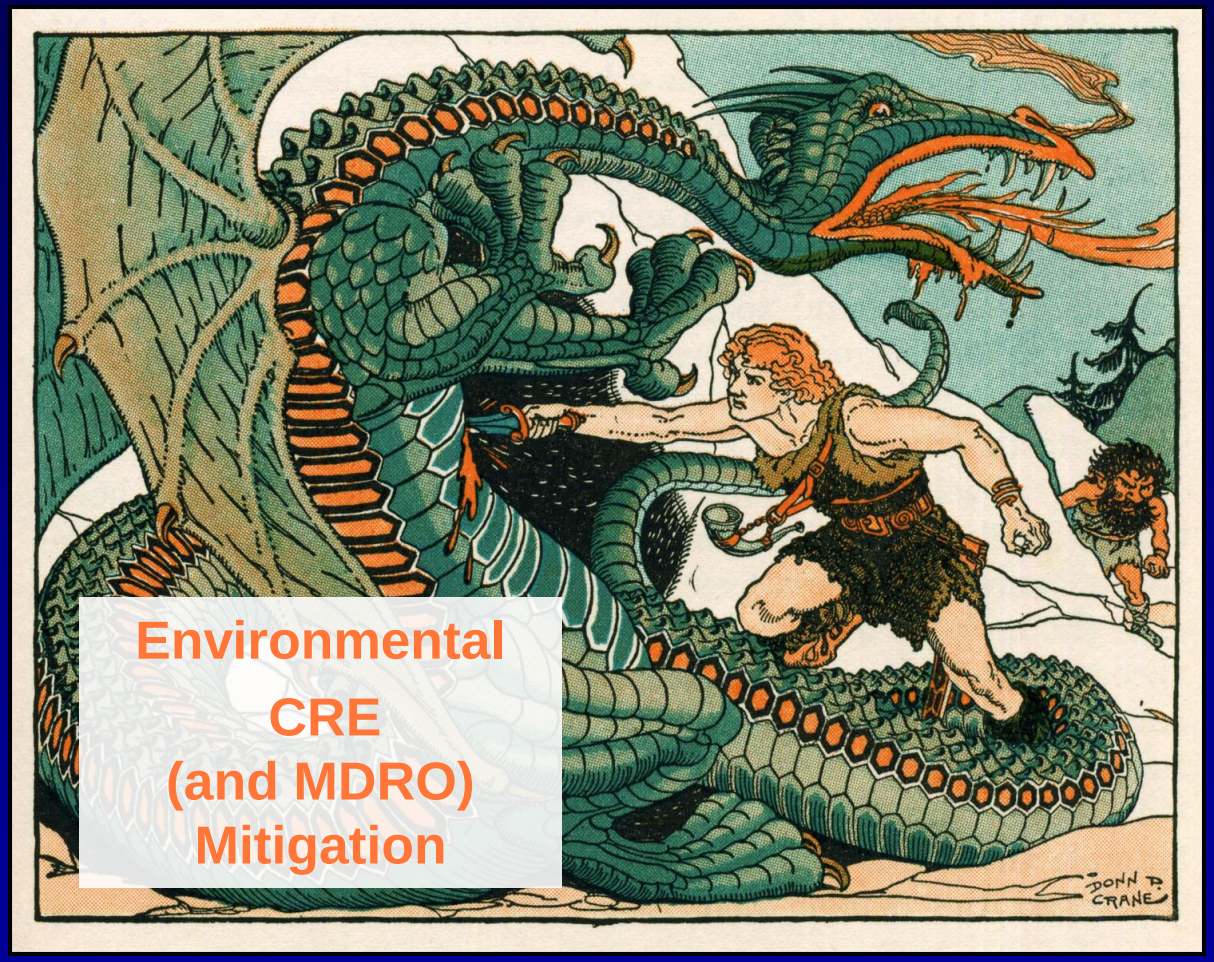
Key Interventions to Prevent CRE Spread

Philip C. Carling, M.D.

Boston University School of Medicine

Michigan CRE Conference
June 11, 2019

What I will be discussing today



What I will be discussing today

- Key realities of Environmental Hygiene
- The new model of HAI prevention
- The Environmental Hygiene Equation
- What about Hand Hygiene?
- What about UV Machines?
- The next big challenge in HAI prevention

Healthcare Environmental Hygiene

- The basic issue has been episodically recognized for almost 200 years
- Personnel costs
  = 10 billion/yr.

Six Basic Realities of environmental hygiene

- All pathogens traditionally associated with HAIs survive well on surfaces

Survival of Pathogens on Dry Environmental Surfaces

C. difficile	> 5 months
Staphylococci	7 months
VRE	4 years
Acinetobacter	5 months
Norovirus	3 weeks
Adenovirus	3 months
Rotavirus	3 months
Hepatitis C	4 weeks

Outbreak v. Non-outbreak VRE

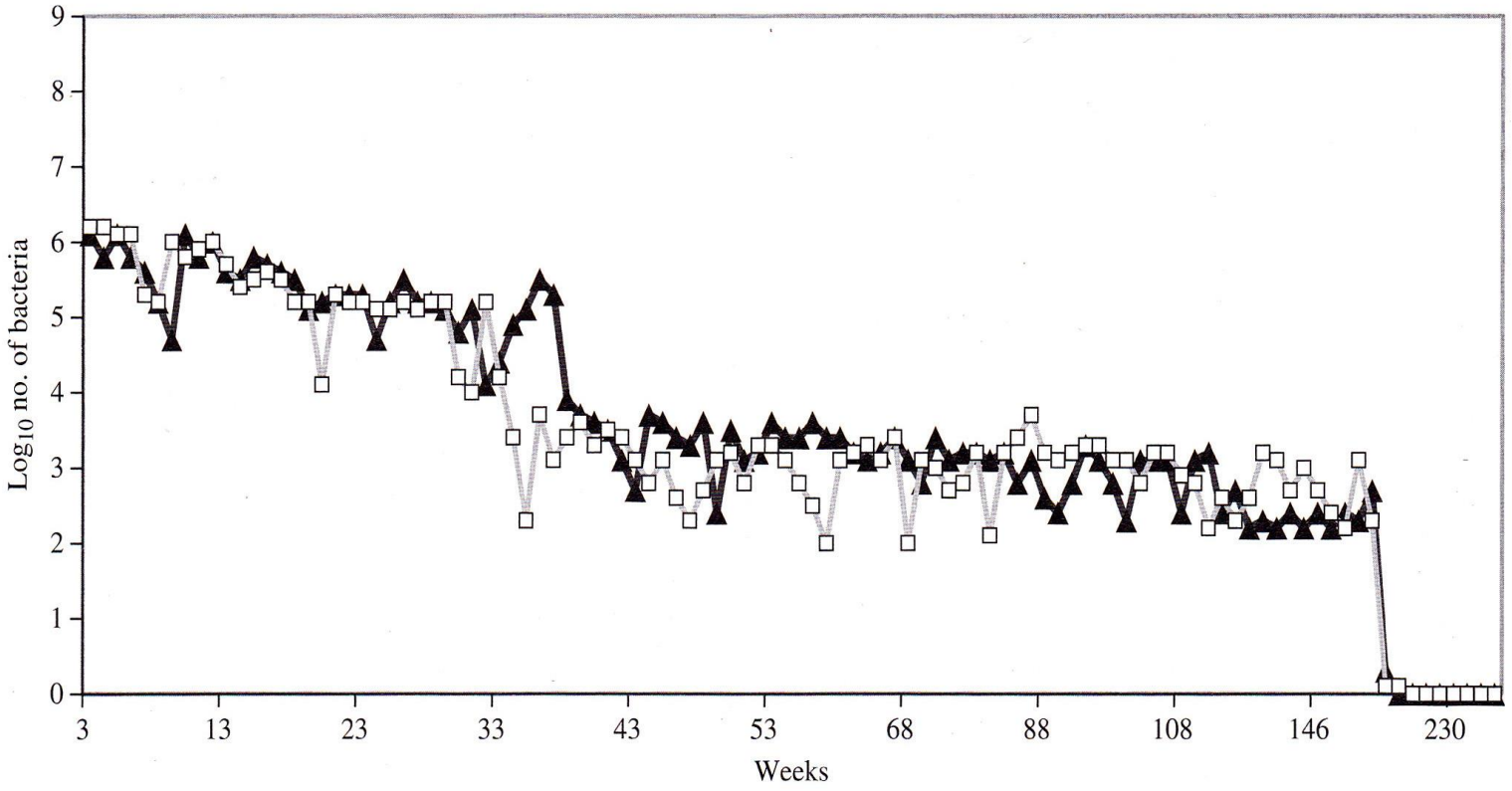


Figure 1. Survival of an outbreak strain (E745; open squares) and a non-outbreak strain (E802; filled triangles) of vancomycin-resistant *Enterococcus faecium* (VREFm).

JHI 2011

Traditional Thinking

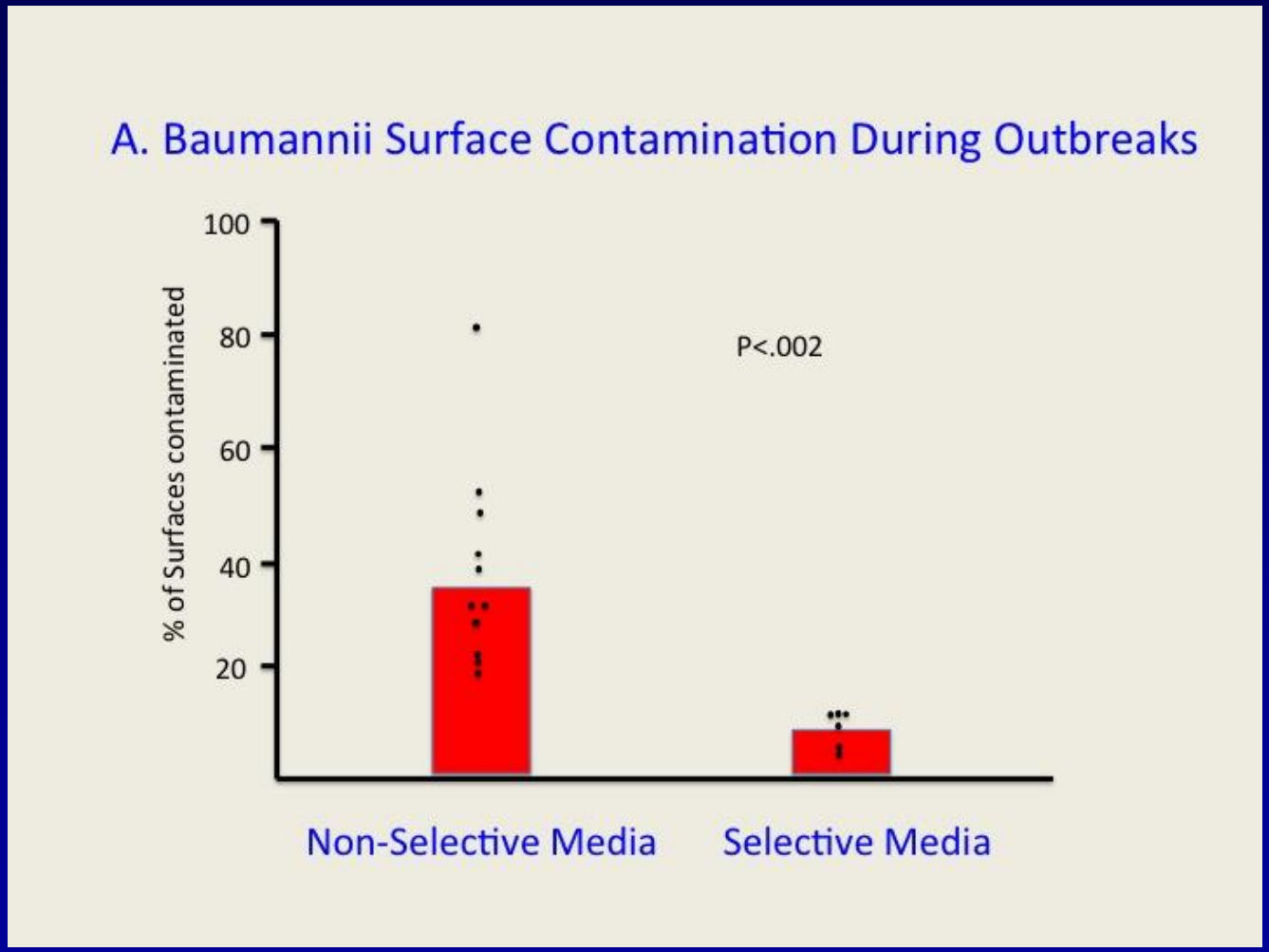
Enterobacteriaceae survive poorly on surfaces…..

Traditional Thinking

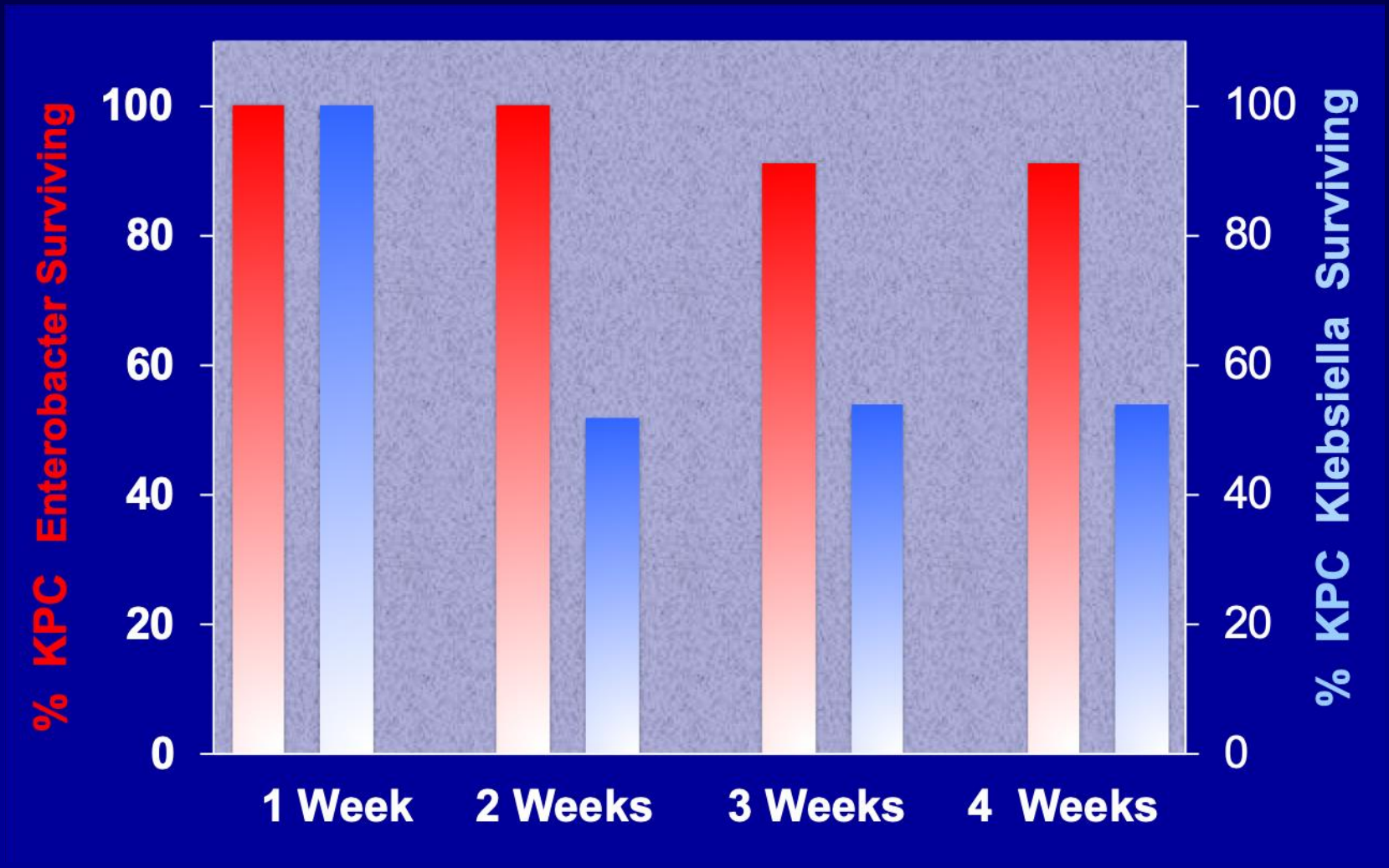
Enterobacteriaceae survive poorly on surfaces…..well

Acinetobacter baumannii Environmental Epidemiology: Do Culture Methods Impact Findings?

*Philip C Carling, MD, FSHEA**, Keith Kaye, MD, FSHEA



KPC Environmental Survival



A. Mathers – Abstract ASM Micro – June 2018

Six Basic Realities of environmental hygiene

- All pathogens traditionally associated with HAIs survive well on surfaces
- The number of pathogens on a surface may be very high but often is low
- The dose to colonize and infect patients is VERY low
- Mechanical removal is the first principle of the

Six Basic Realities of environmental hygiene

All pathogens traditionally associated with HAIs survive well on surfaces

The number of pathogens on a surface may be very high but often is low

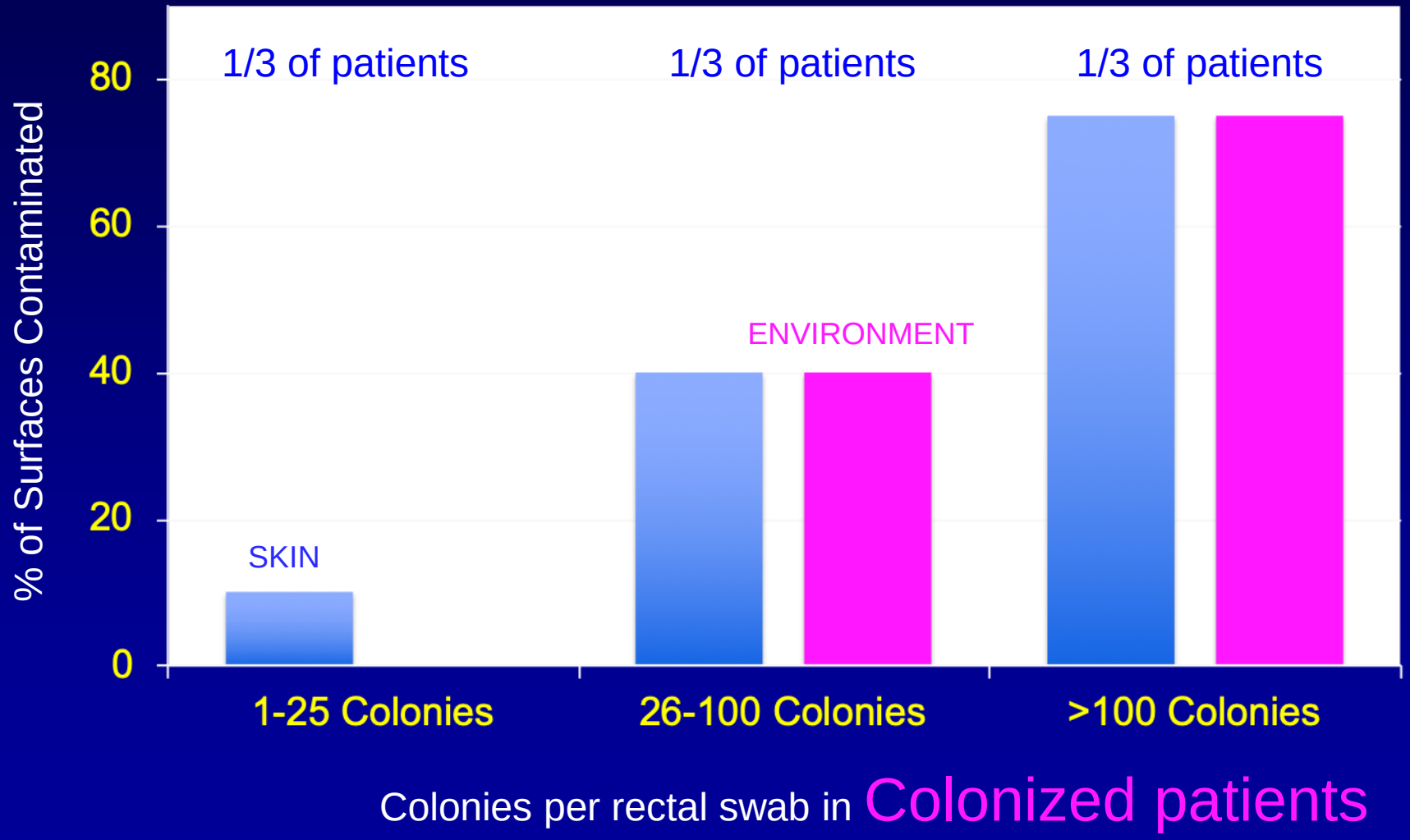
The dose to colonize and infect patients is VERY LOW

Mechanical removal is the first principle – if the surface is not physically cleaned you don't achieve anything

Six Basic Realities of environmental hygiene

- All pathogens traditionally associated with HAIs survive well on surfaces
- The number of pathogens on a surface may be very high but often is low
- The dose to colonize and infect patients is VERY low
- Patients continue to shed pathogens onto surfaces while asymptomatically colonized, not just infected

Contamination Depends on the Concentration of CD Spores in Stool



C. Donskey – ID Week Presentation

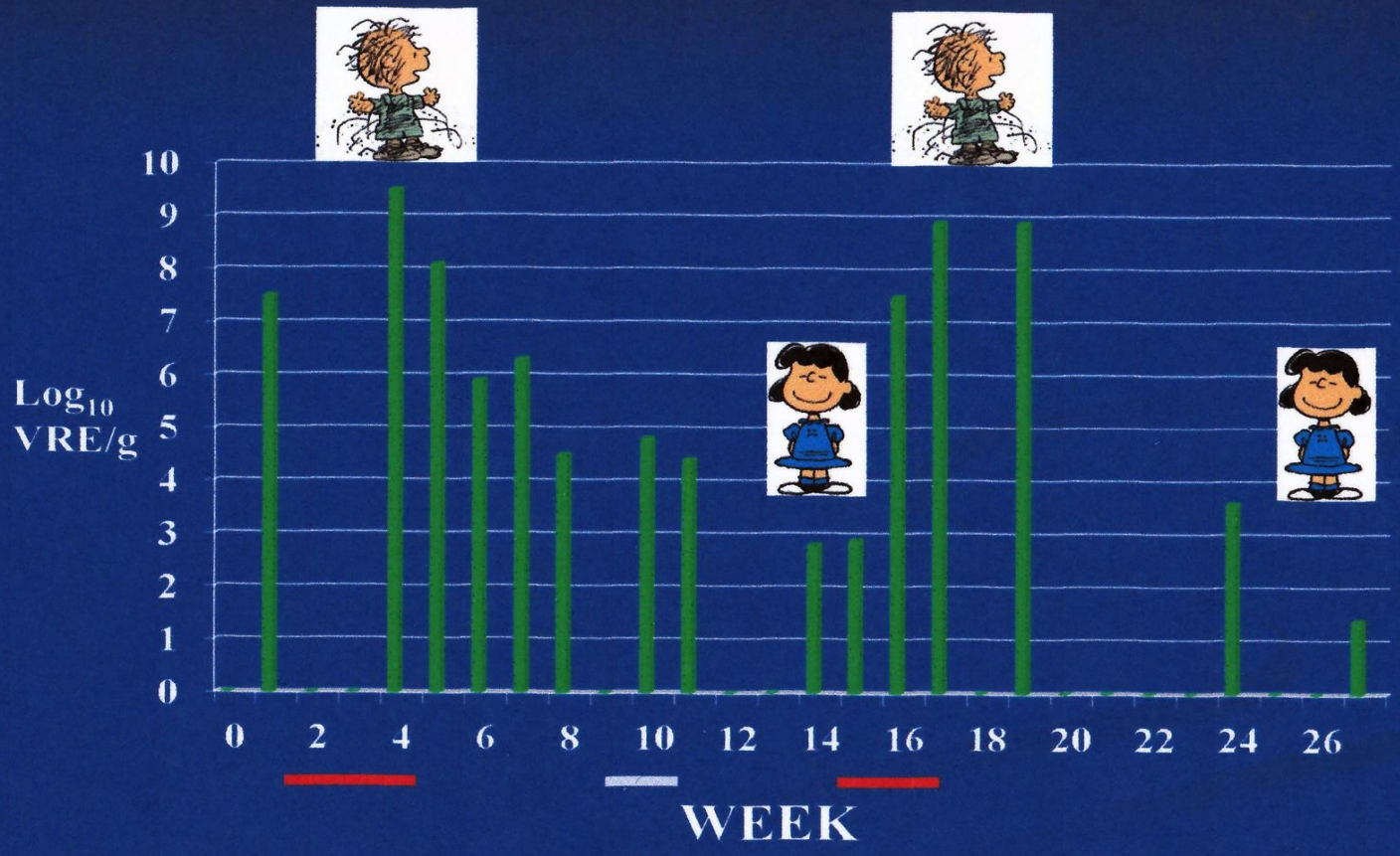
Contamination Depends on the Concentration of CD Spores in Stool

C. Donskey – ID Week Presentation

Six Basic Realities of environmental hygiene

- All pathogens traditionally associated with HAIs survive well on surfaces
- The number of pathogens on a surface may be very high but often is low
- The dose to colonize and infect patients is VERY low
- Patients continue shed pathogens on to surfaces
  - Asymptomatic shedding increases with antibiotic exposure
- Hands of HCWs frequently become contaminated

Shedding of pathogens varies over time



Donskey CJ, et al. N Engl J Med 2000;343:1925-32

Six Basic Realities of environmental hygiene

All pathogens traditionally associated with HAIs survive well on surfaces

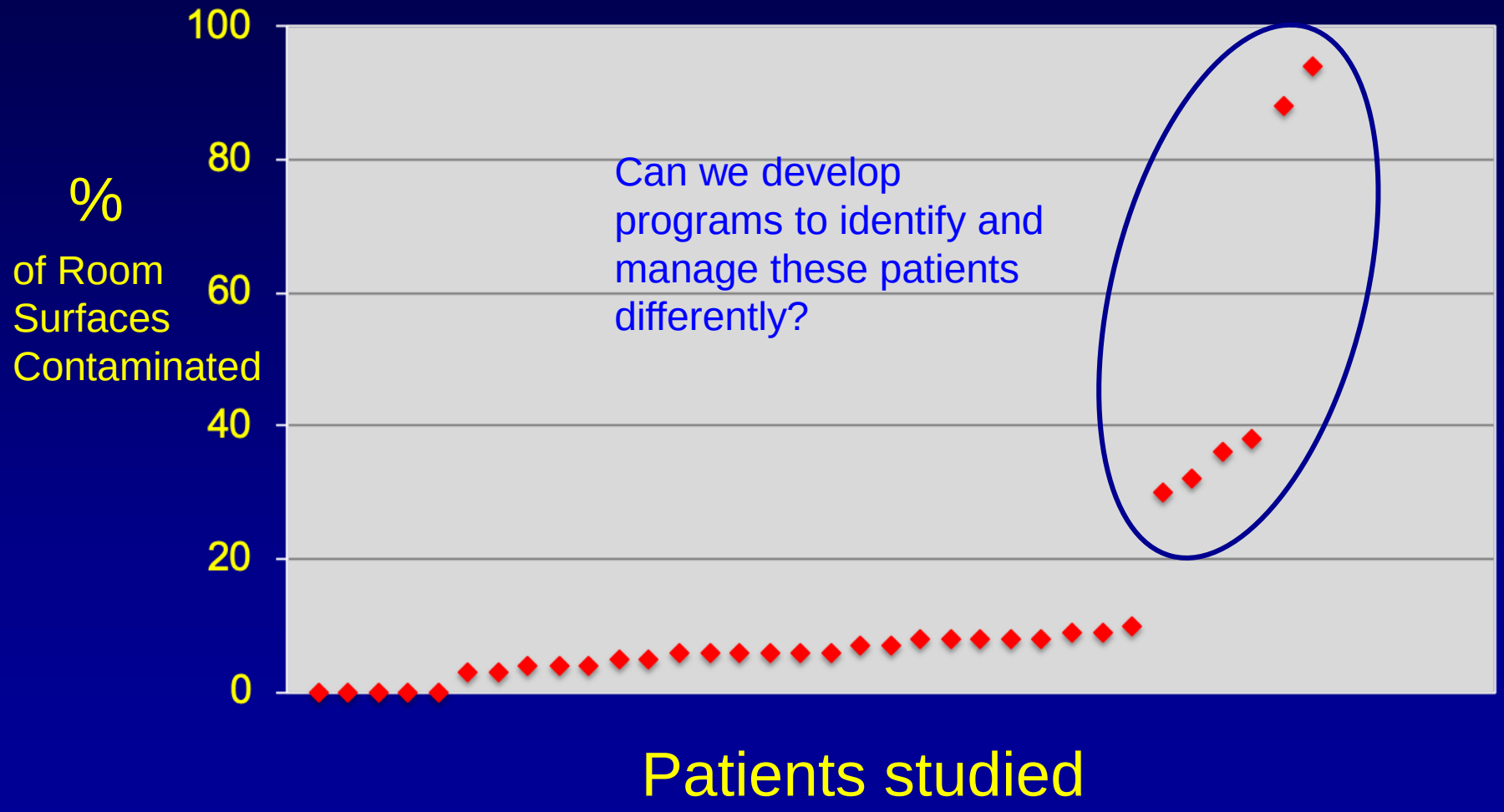
The number of pathogens on a surface may be very high but often is low

The dose to colonize and infect patients is VERY low

- Patients continue shed pathogens on to surfaces

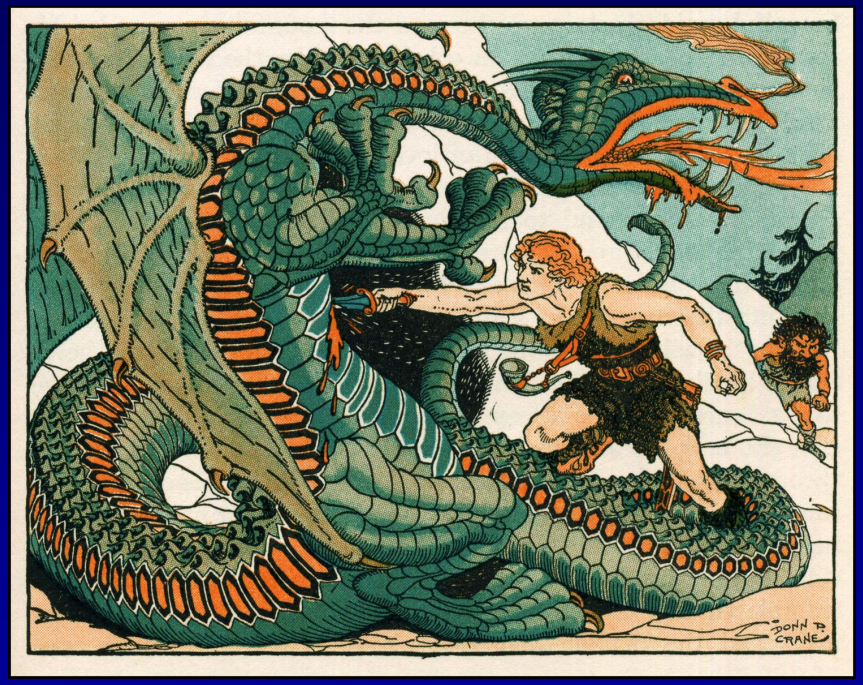
- Asymptomatic super shedders may account for > 75% of transmission but there is no way to identify them

CRE environmental contamination



S. Fridkin – CDC Presented at ID Week 2014

For the past 20 years we have been attacking the pathogen of the year



- C. difficile
- MRSA
- VRE
- MDR – GNB
- C. difficile
- Norovirus when it is your problem

The new model of HAI prevention

Vertical Interventions

MRSA screening

Bleach for CDI terminal cleaning

HAI pathogen specific programs

- C. difficile
- VRE
- CRE

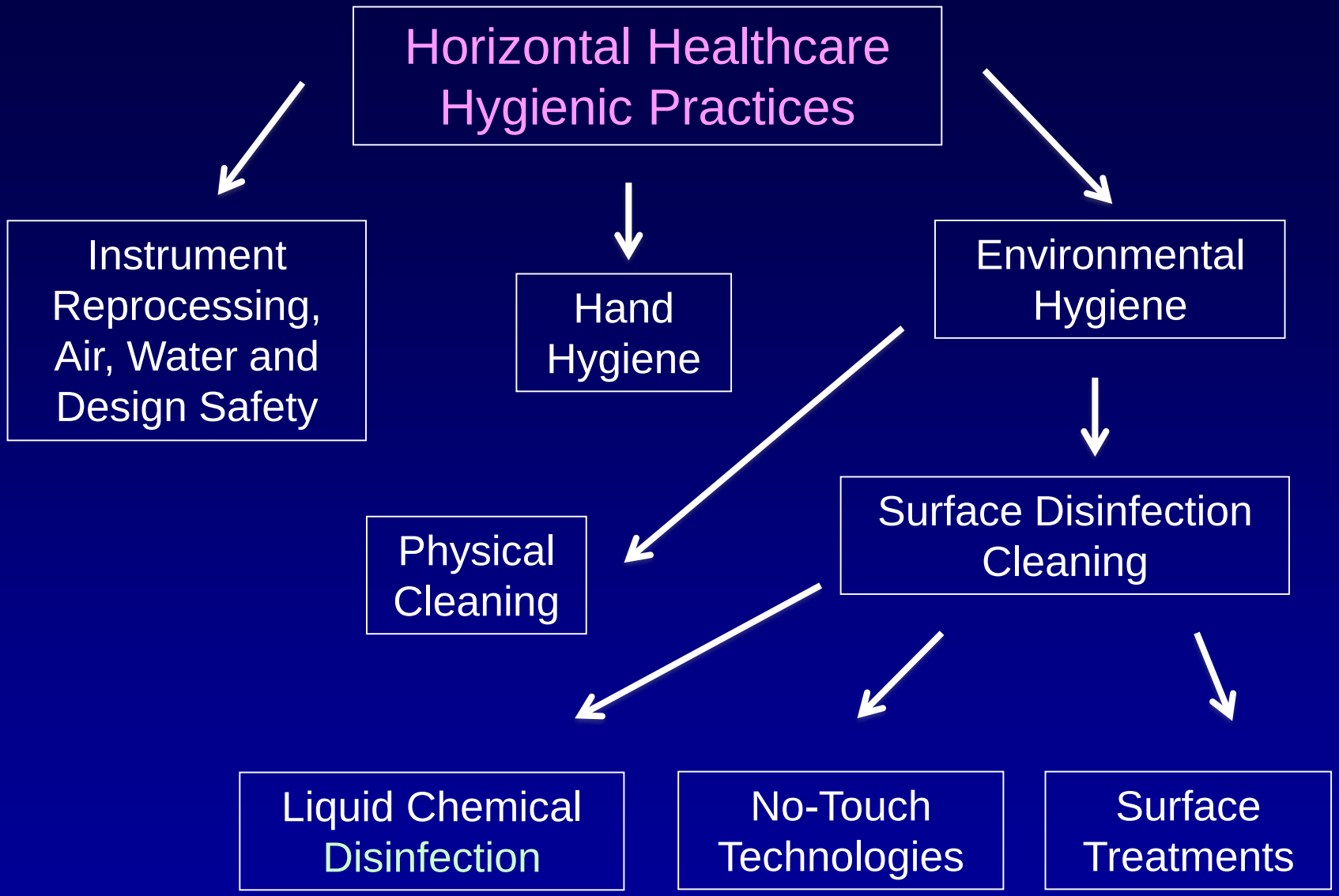
Horizontal Interventions

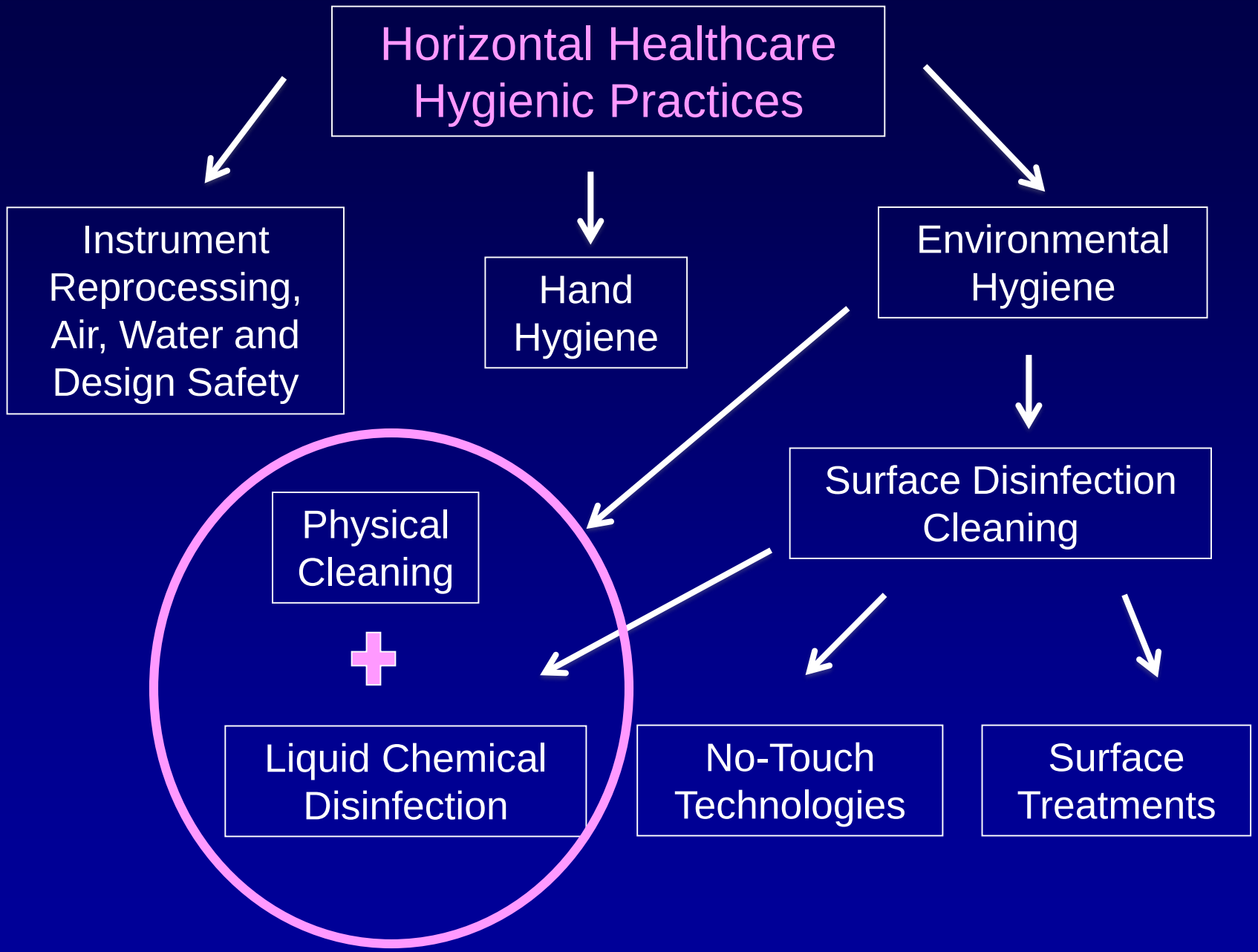
Hand Hygiene

Environmental Hygiene

Normothermia and Glucose control in surgery

Chlorhexadine Bathing ?


Horizontal Healthcare Hygienic Practices
Instrument Reprocessing, Air, Water and Design Safety
Hand Hygiene
Environmental Hygiene
Physical Cleaning
Surface Disinfection Cleaning
Liquid Chemical Disinfection
No-Touch Technologies
Surface Treatments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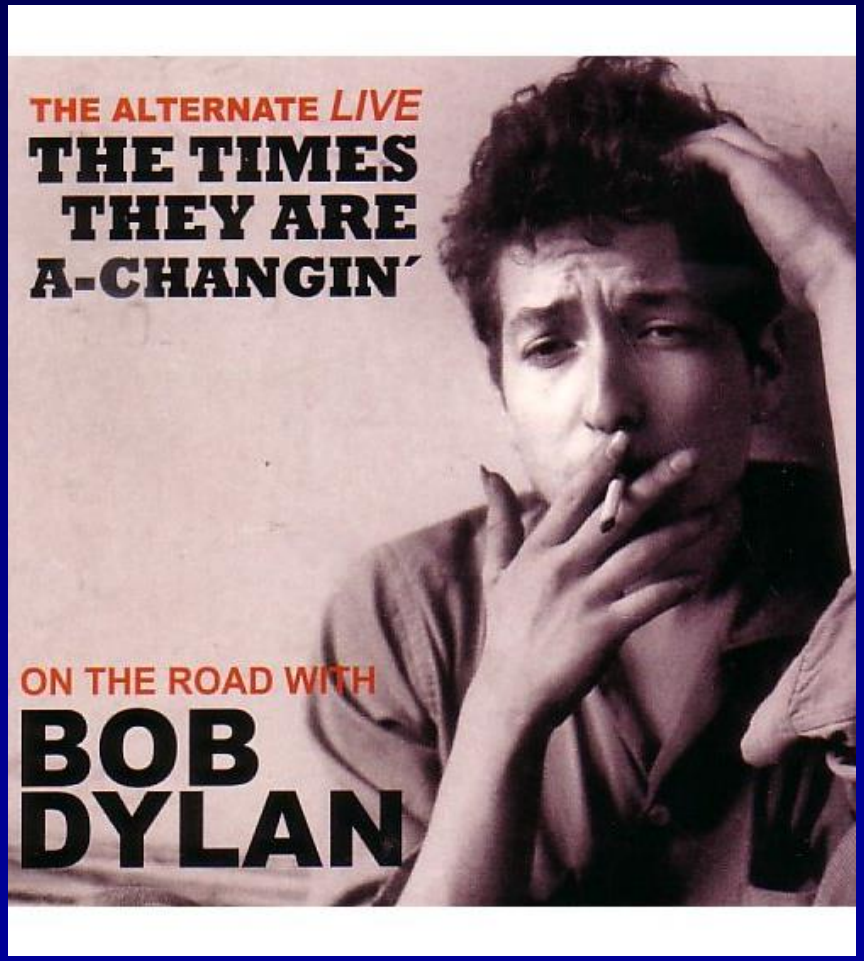
The Environmental Hygiene Equation

Optimized Product

Optimized Practice

P. Carling 2010

Optimized Product - Healthcare Surface Disinfectants – Update 2018



- For the first time ever (almost), the surface disinfectant landscape is changing.

Good News

More Rapid Sporicides

And

Green Sporicides

Bad News

Lots of marketing

You need to look for

Clinical Comparisons

Complex cost issues

So what about wipes??

Lots of colors, different labels, undocumented claims

So what about wipes??

Lots of colors, different labels, undocumented claims

Remember Gov. approval is only for the chemical

So what about bleach wipes?

- Nice concept
- Some pulled from US markets – false claims
- Maintaining moisture for “kill time” ?
- None studied objectively or in comparison to non-bleach wipes
- Bleach damage to surfaces – not studied

Traditional Wipes - The bottom line:

Pro:

- Handy
- Easy to use

Con:

- Not effectively microbacidal:
  - QACs –Slow
  - Alcohol – Evaporates
- Spread pathogens

Easy to forget the Sattar Mantra:

"1 wipe,
1 surface,
1 direction,
1 time"

The Environmental Hygiene Equation

Optimized Product

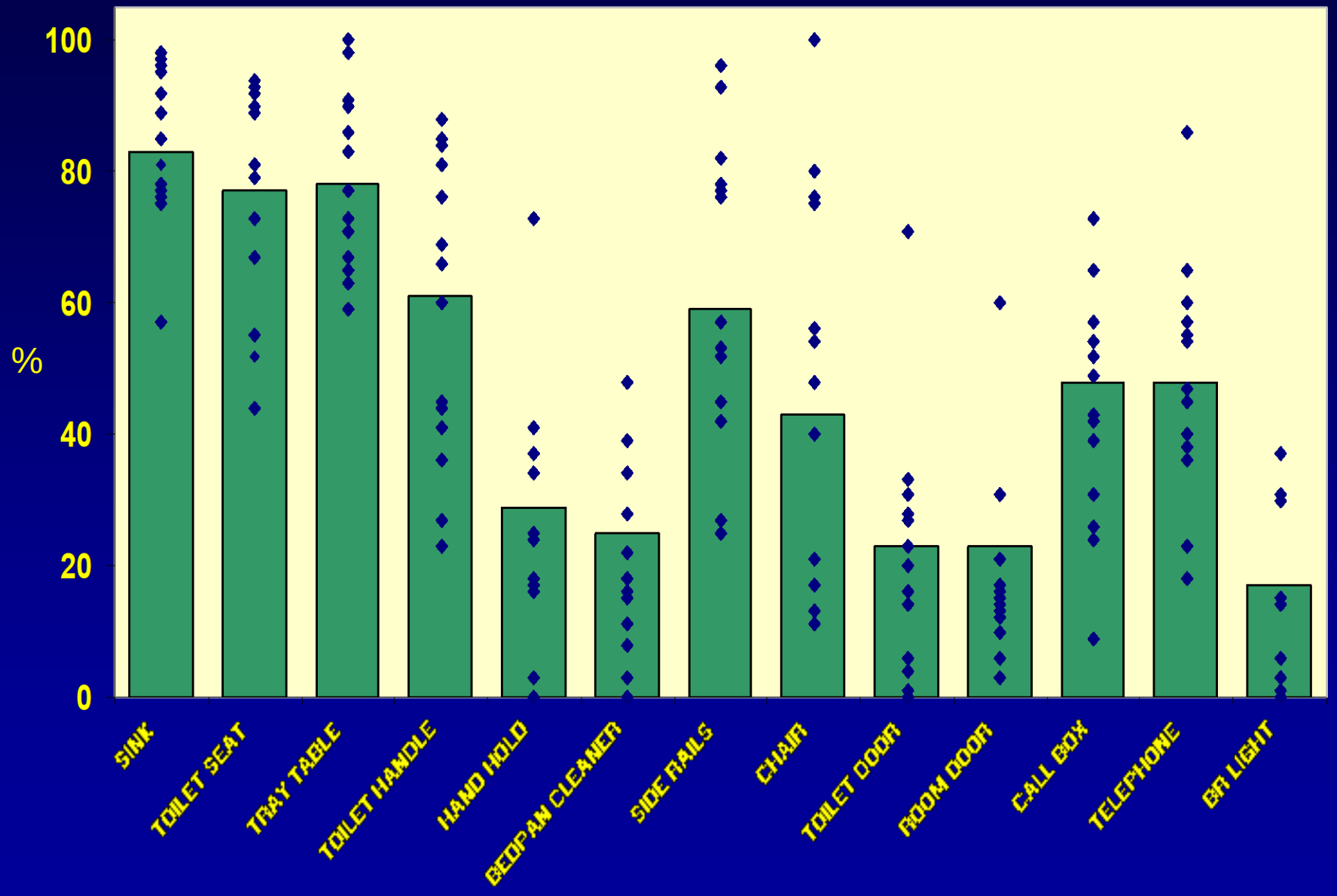
Optimized Practice

P. Carling 2010

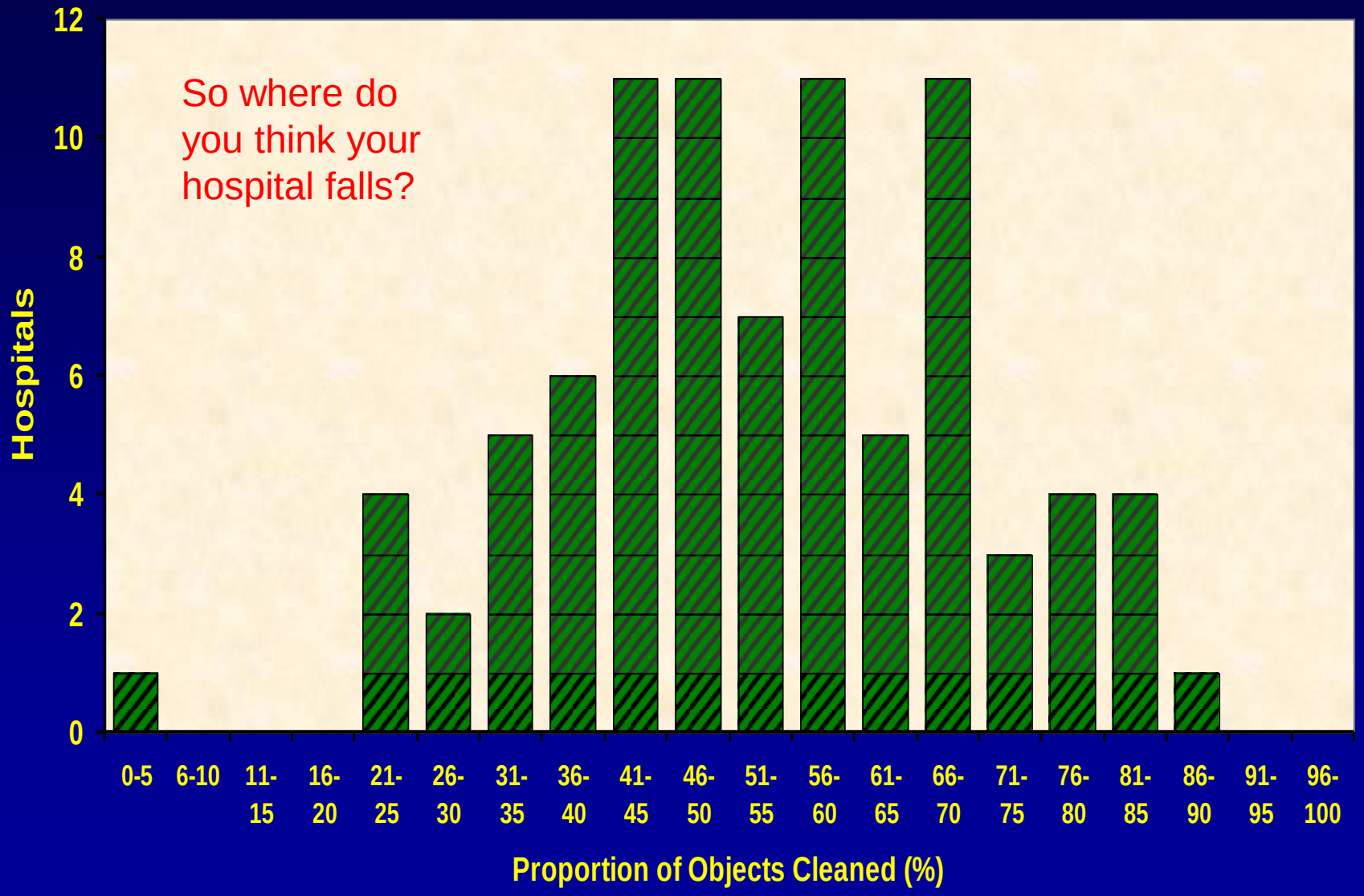
What's the problem…? I know that my hospital is being well cleaned !

Just look at the shiny floors !!

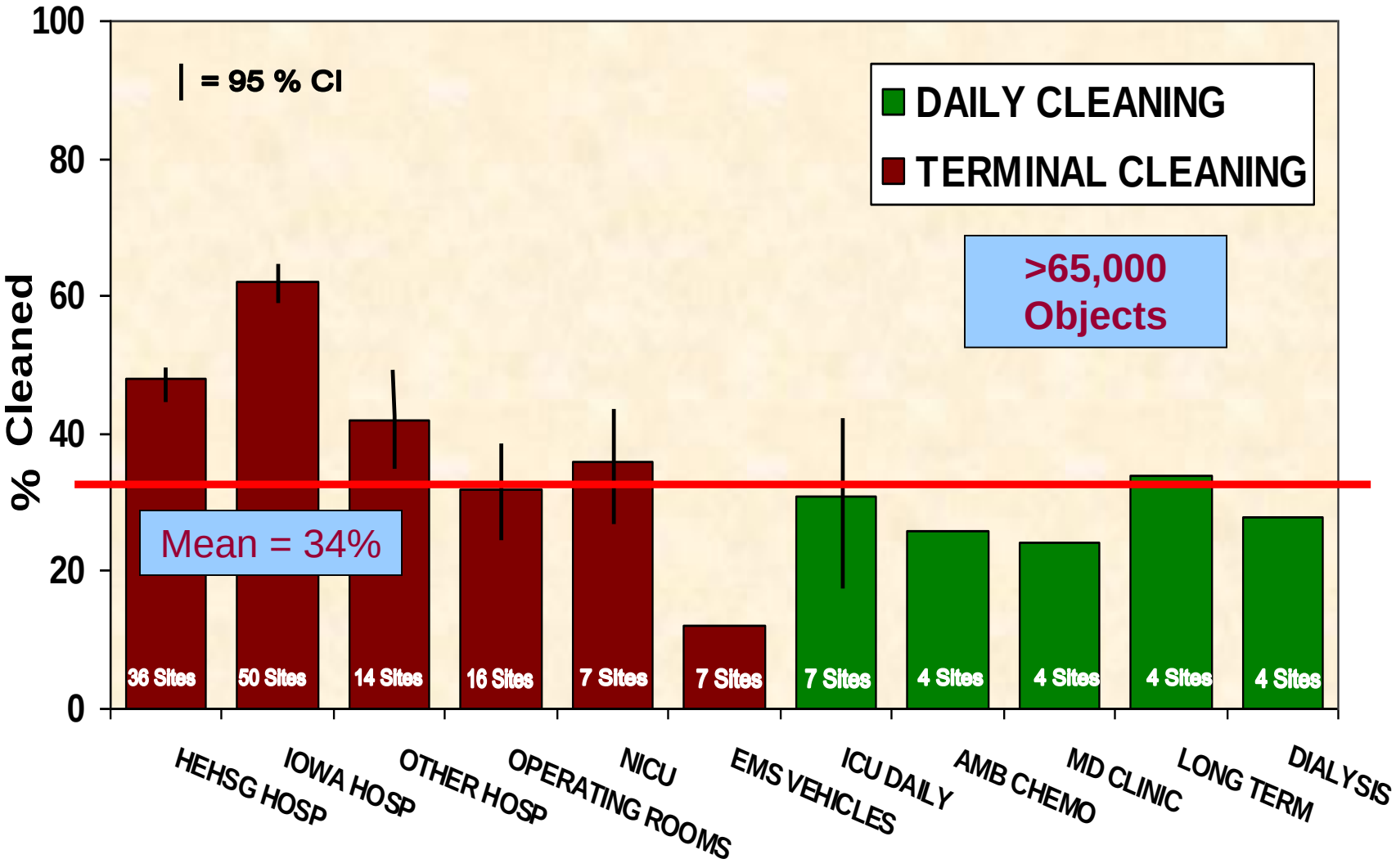
PROPORTION OF OBJECTS CLEANED AS PART OF TERMINAL ROOM CLEANING IN 20 ACUTE CARE HOSPITALS



Baseline Environmental Evaluation of 82 Acute Care Hospitals



Thoroughness of Environmental Cleaning

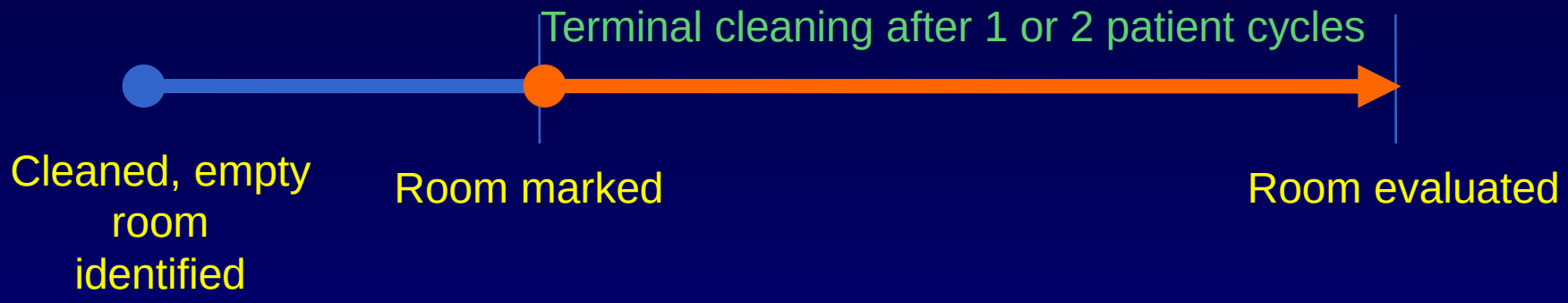


Optimized Practice

A Program:

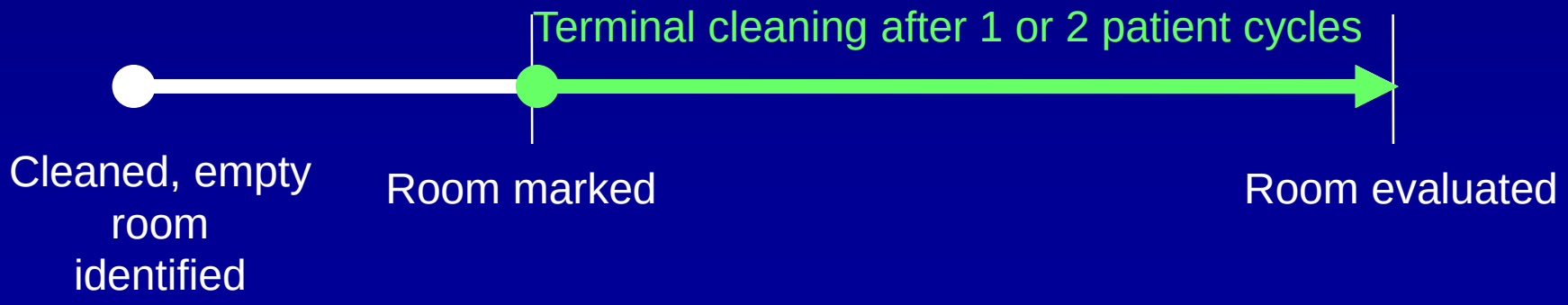
Prospective objective monitoring of patient zone cleaning practice utilizing an ongoing structured process improvement system

Phase I: Covert Baseline Environmental Cleaning Evaluation



Phase II: A. Programmatic Analysis
B. Educational Interventions – ES staff

Phase III: Re-evaluation of Cleaning and Feedback to ES



INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY NOVEMBER 2008, VOL. 29, NO. 11

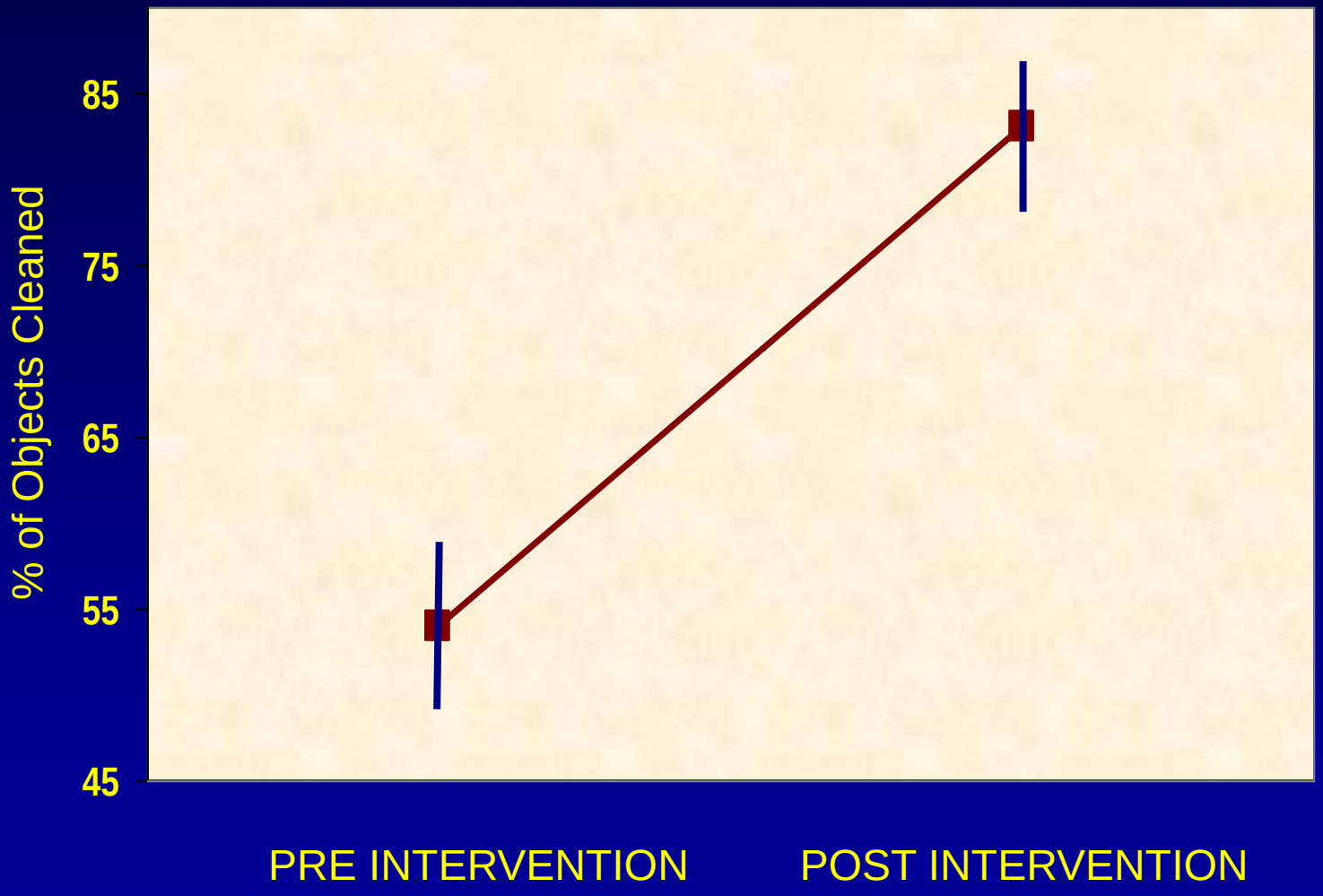
ORIGINAL ARTICLE

Improving Cleaning of the Environment Surrounding Patients in 36 Acute Care Hospitals

Philip C. Carling, MD; Michael M. Parry, MD; Mark E. Rupp, MD; John L. Po, MD, PhD; Brian Dick, MS, CIC; Sandra Von Beheren, RN, BSN, MS, CIC; for the Healthcare Environmental Hygiene Study Group

RESULTS

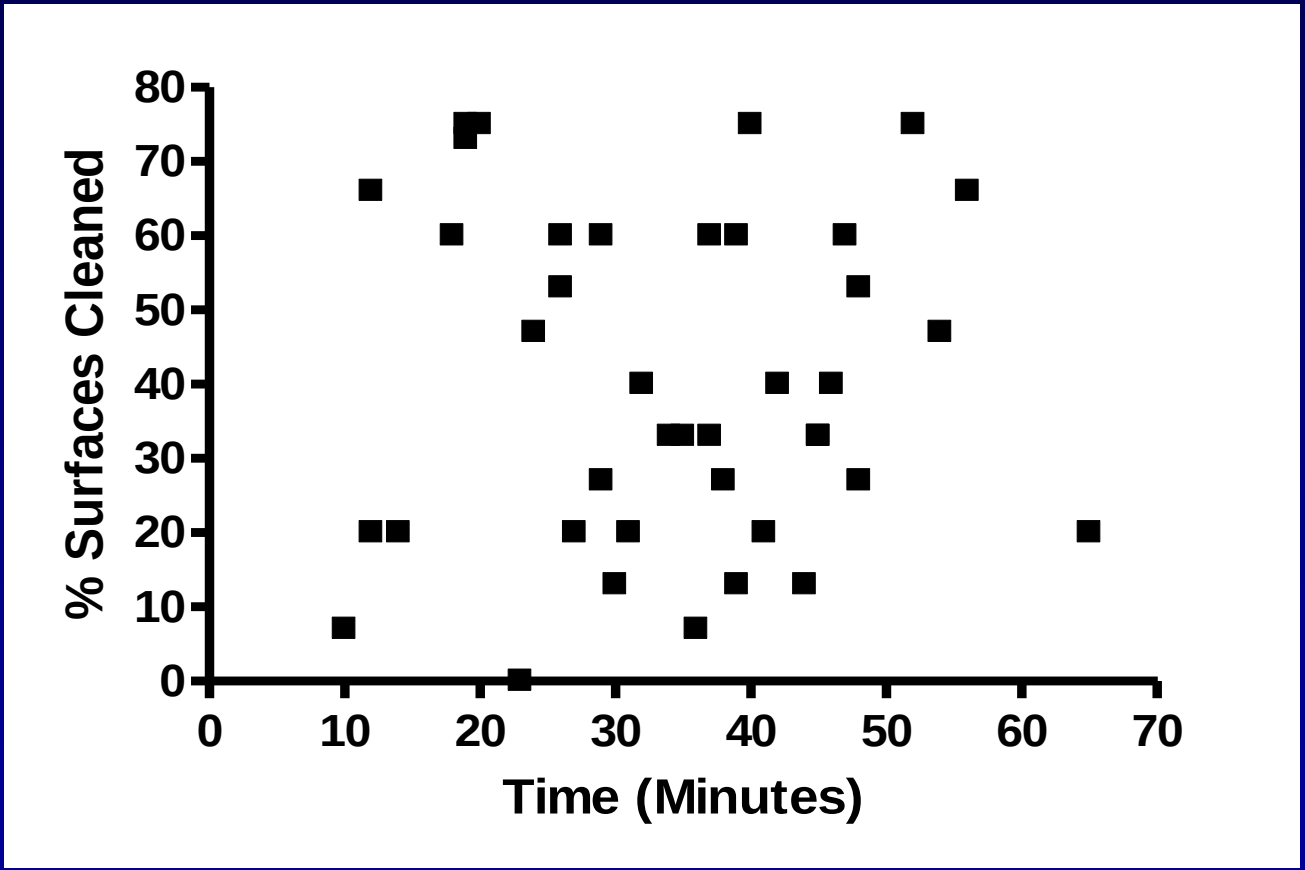
Hospitals Environmental Hygiene Study Group
82 Hospital Results



Resource Neutral

P = <.0001

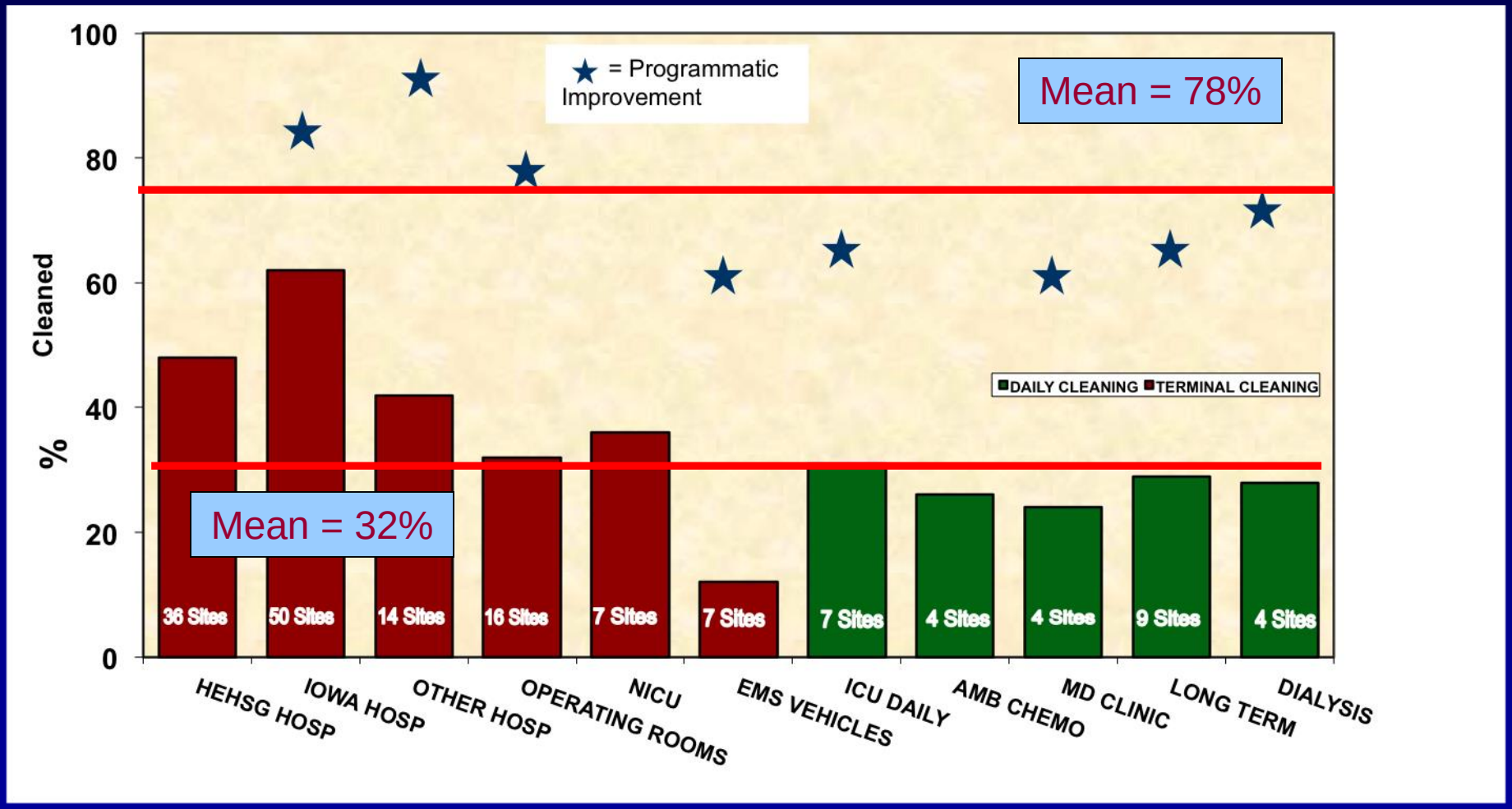
Is it a surprise that this degree of improvement was resource neutral ??



Terminal Cleaning

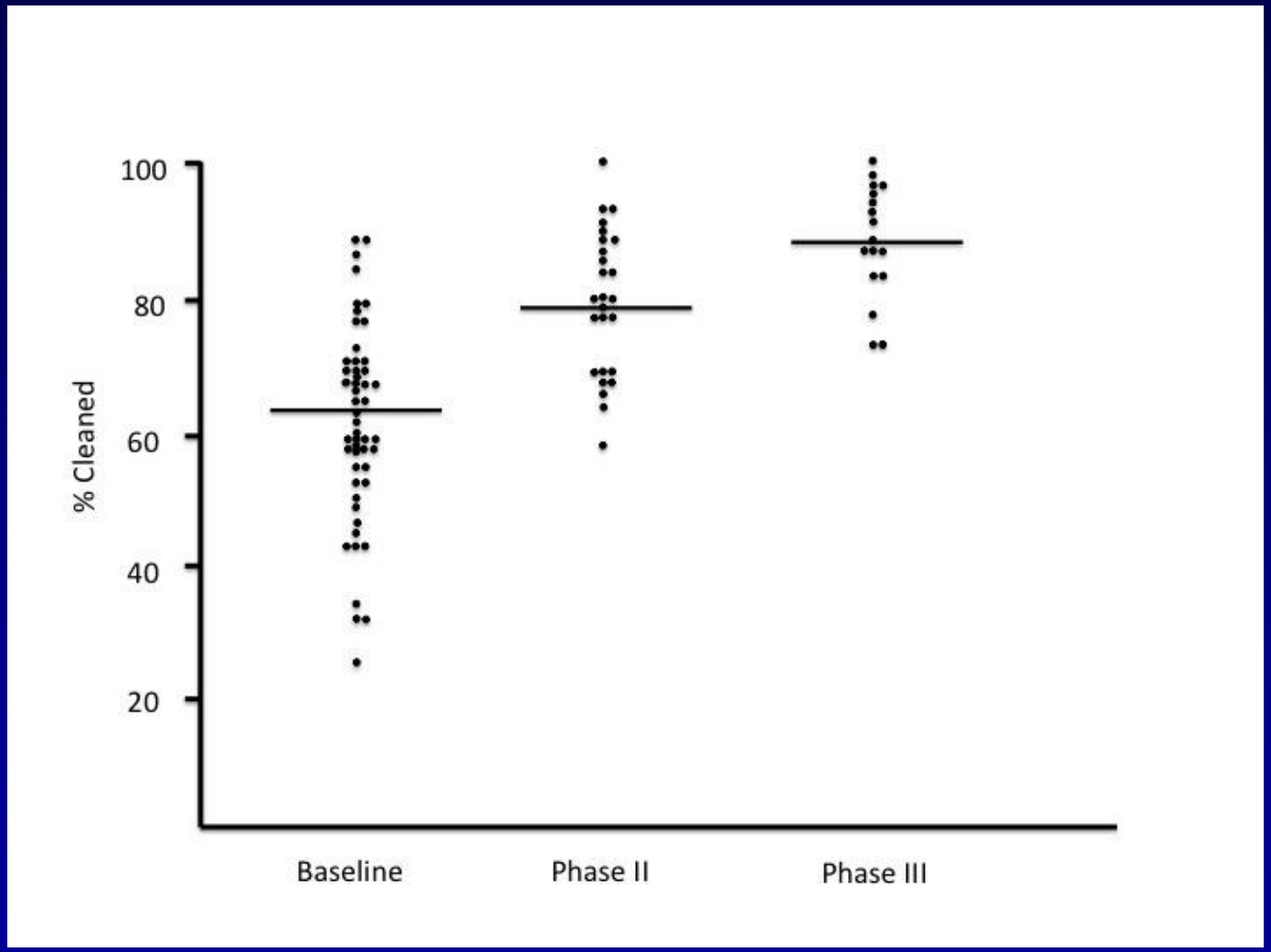
Rupp ME, Adler A, Schellen M, Abstract 203 Fifth Decennial

Improvement Environmental Cleaning According to Policy with DAZO Program



Health Care Environmental Hygiene Research Group Studies 2004 - 2012

The Iowa Project – 56 Hospitals



CDC Recommendations

Acute Care Hospitals should implement a:

Level I Program:

Basic interventions to optimize disinfection cleaning policies, procedures and ES staff education and practice. When completed move to Level II Program

Level II Program:

All elements of Level I + Objective monitoring

Options for Evaluating Environmental Cleaning

October 2010

National Center for Emerging and Zoonotic Infectious Diseases

Division of Healthcare Quality Promotion

CDC Recommendations 2010

Web Link:

http://www.cdc.gov/HAI/toolkits/Evaluating-Environmental-Cleaning.html

Options for Evaluating Environmental Cleaning

October 2010

National Center for Emerging and Zoonotic Infectious Diseases

Division of Healthcare Quality Promotion

Optimizing Health Care Environmental Hygiene

Philip C. Carling, MD

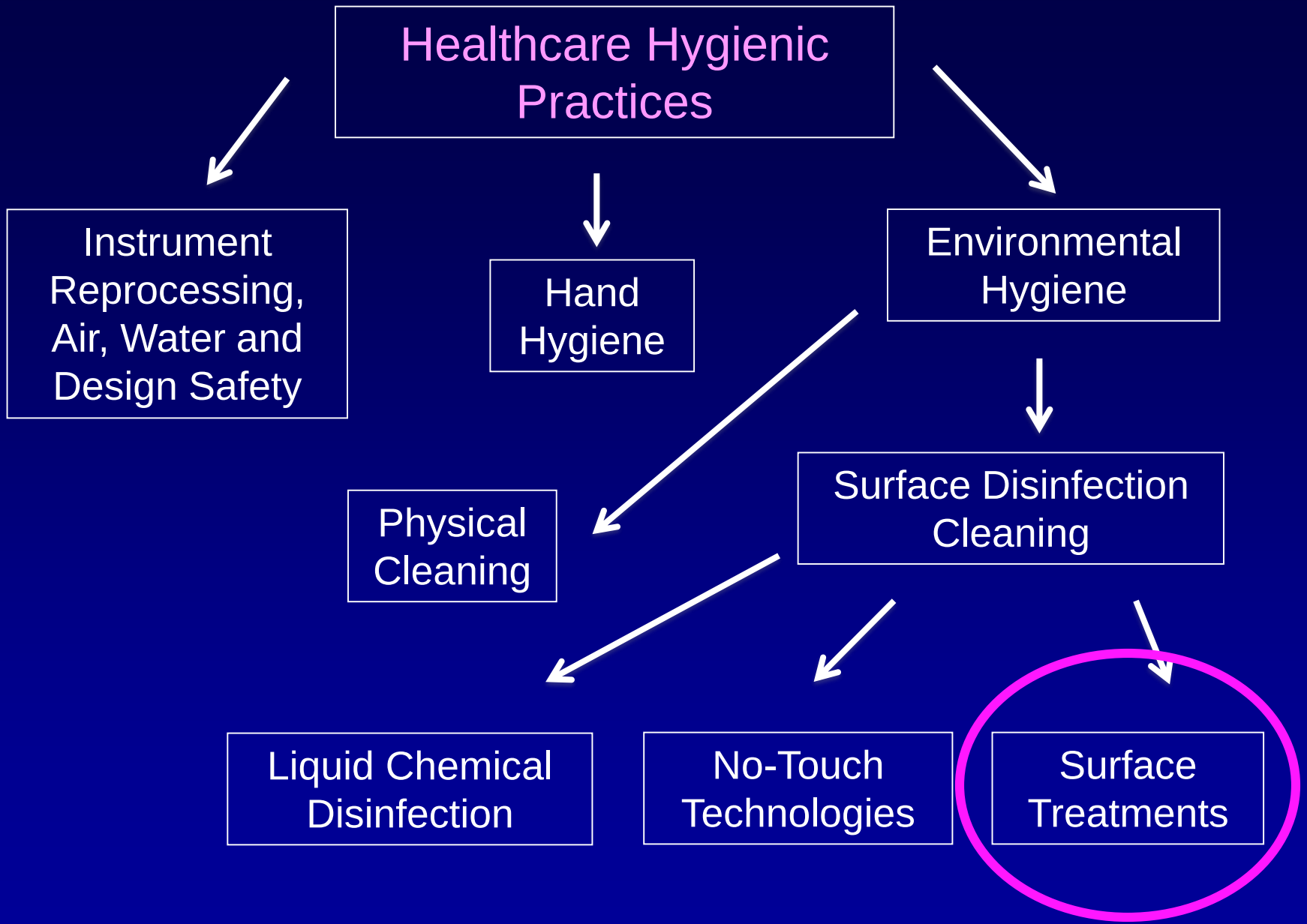
KEYWORDS

- Hygienic practice • Hand hygiene • Environmental hygiene
- Optimizing disinfection cleaning

KEY POINTS

- During the past decade it has become widely appreciated that patient area environmental surfaces play an important role in the transmission of all health care–associated pathogens (HAPs).
- Clarification of opportunities to have a favorable impact on such transmission has led to new approaches for optimizing the structure and practice of health care environmental hygiene.
- Although both hand hygiene and environmental hygiene represent basic horizontal interventions to prevent transmission of HAPs, there is a need for these 2 interventions to be recognized as interdependent.
- Several technologic interventions to augment environmental hygiene have been recently developed but remain to be objectively evaluated in well-designed clinical studies.

Infect Dis Clin N Am 30 (2016) 639-660.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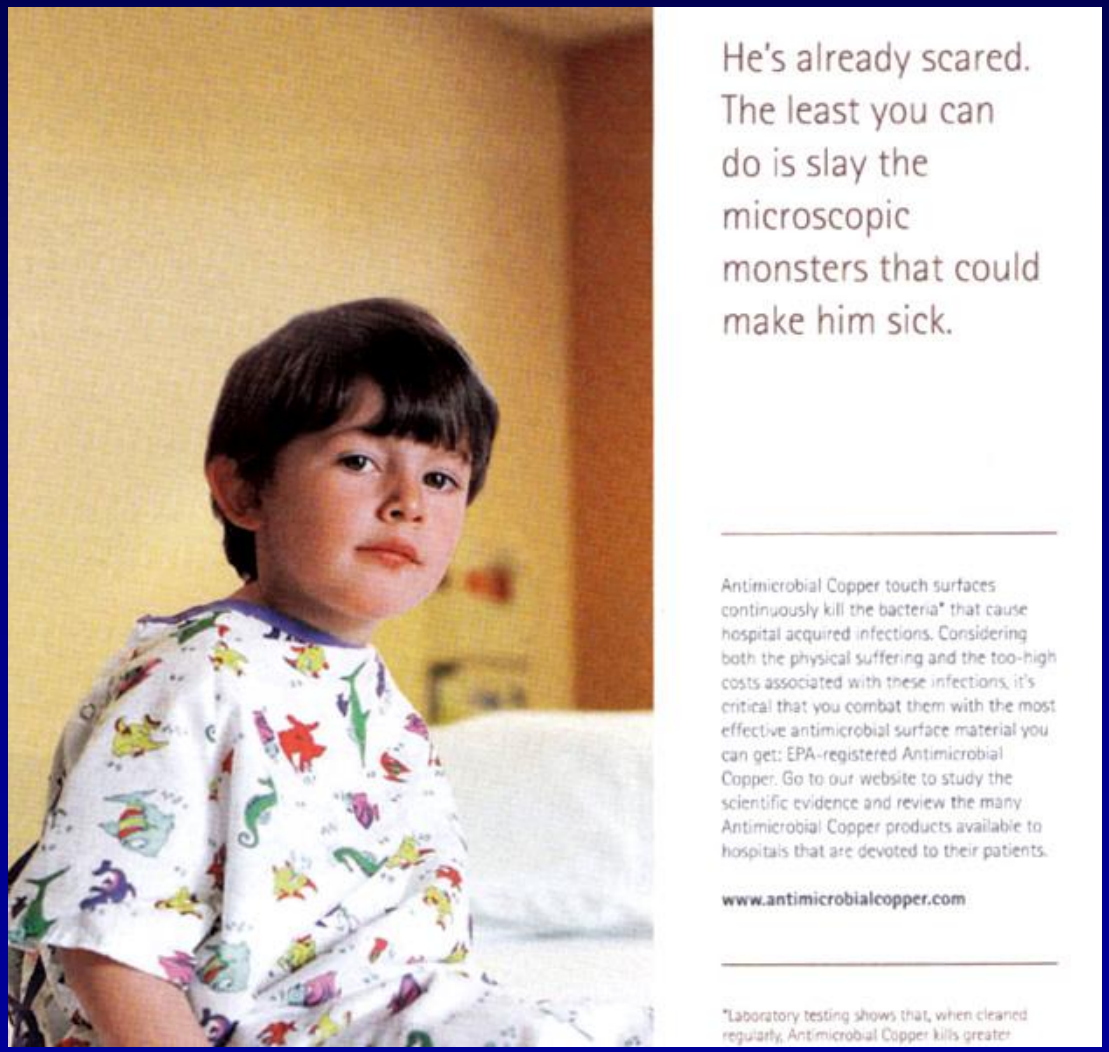
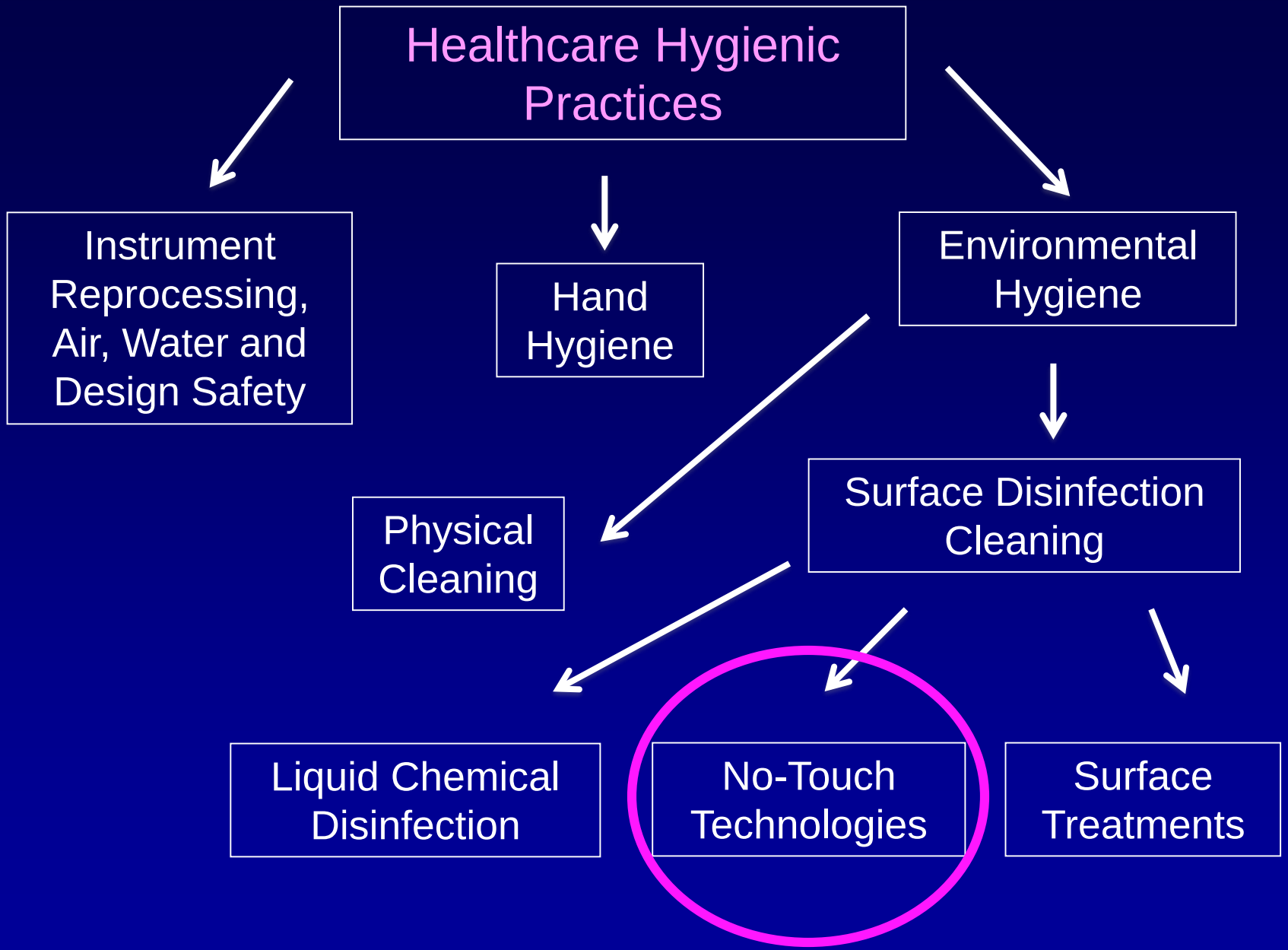
Copper non-use guilt

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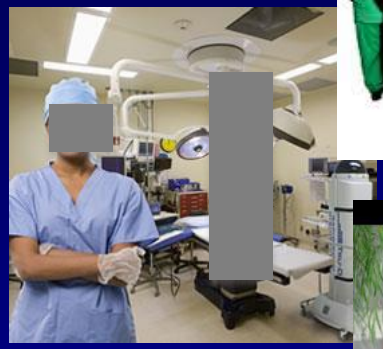
High-tech house cleaning

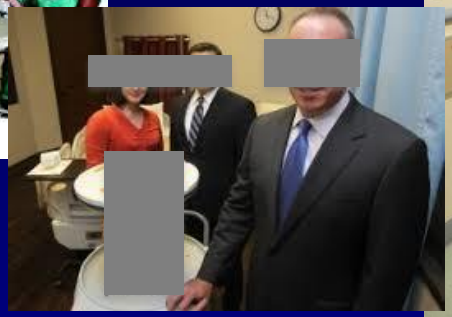
Advanced disinfection systems wield lethal weapons against pathogens

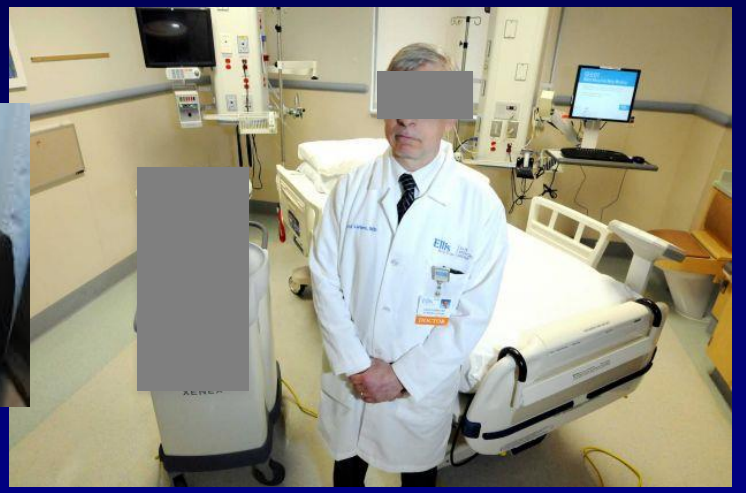
Non-touch Technologies

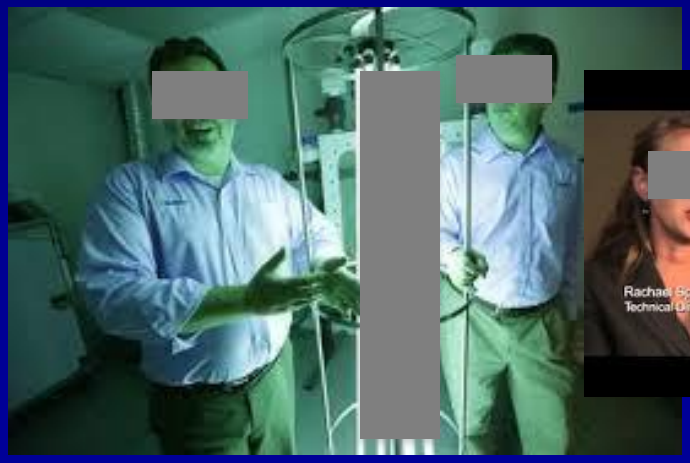
Cool Pictures

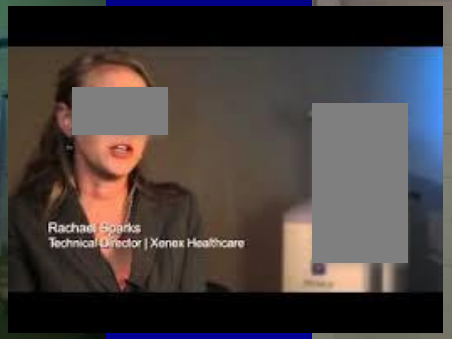
Marketing testimonials are unanimous in their enthusiastic support

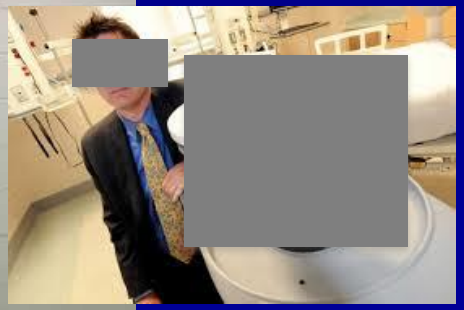






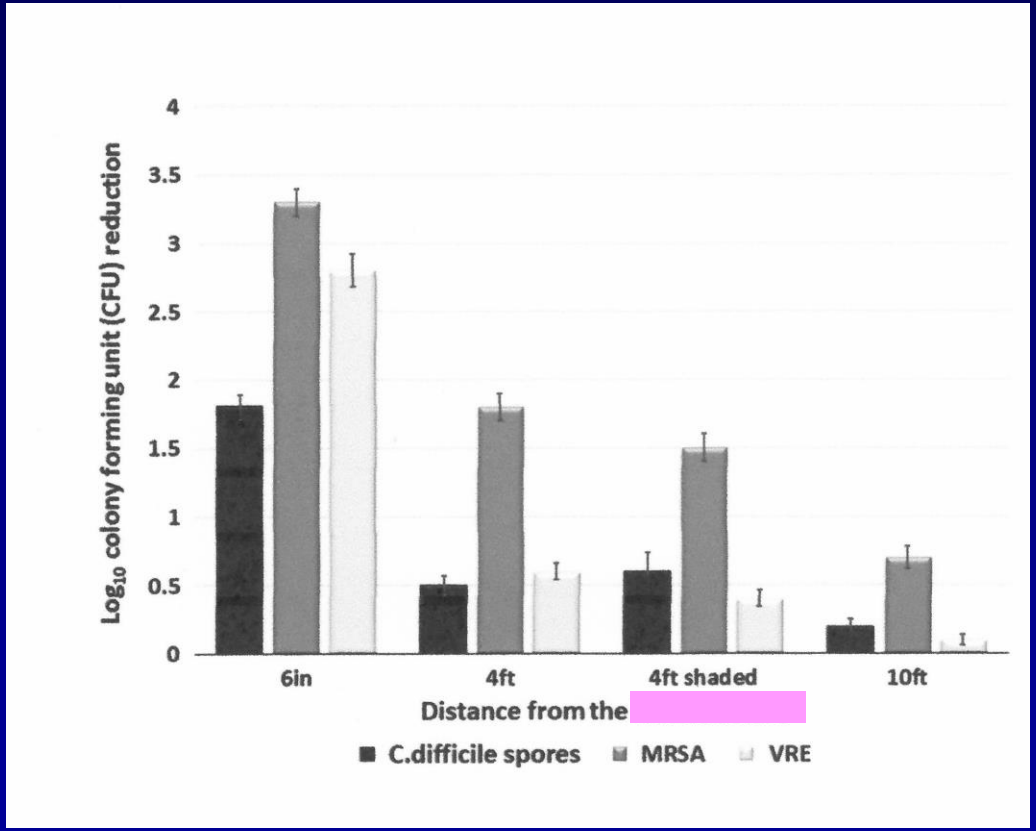






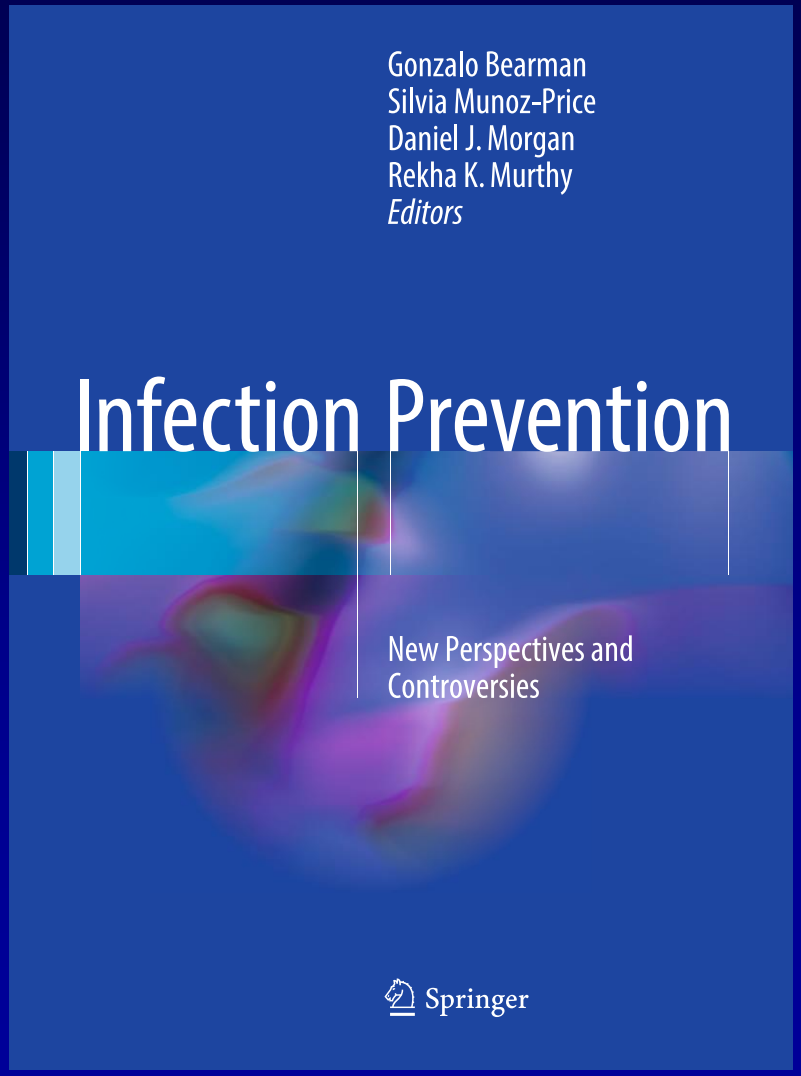
But how well do they work in the real world?

Evaluation of a [redacted] Ultraviolet Disinfection System for Reduction of Healthcare-Associated Pathogens in Hospital Rooms



Infection Control and Hospital Epidemiology – February 2015

So, what is the bottom line about the use of UV Technology?



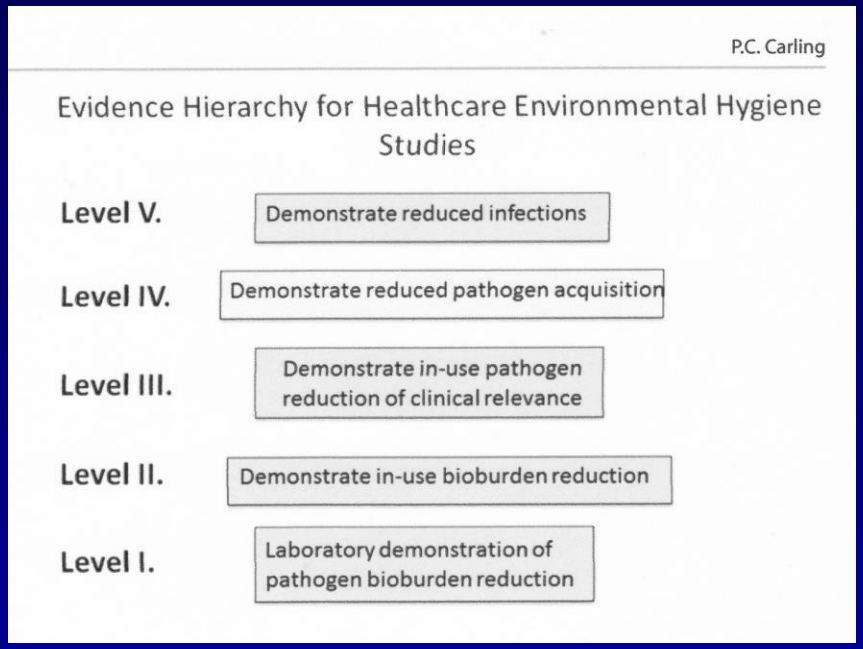
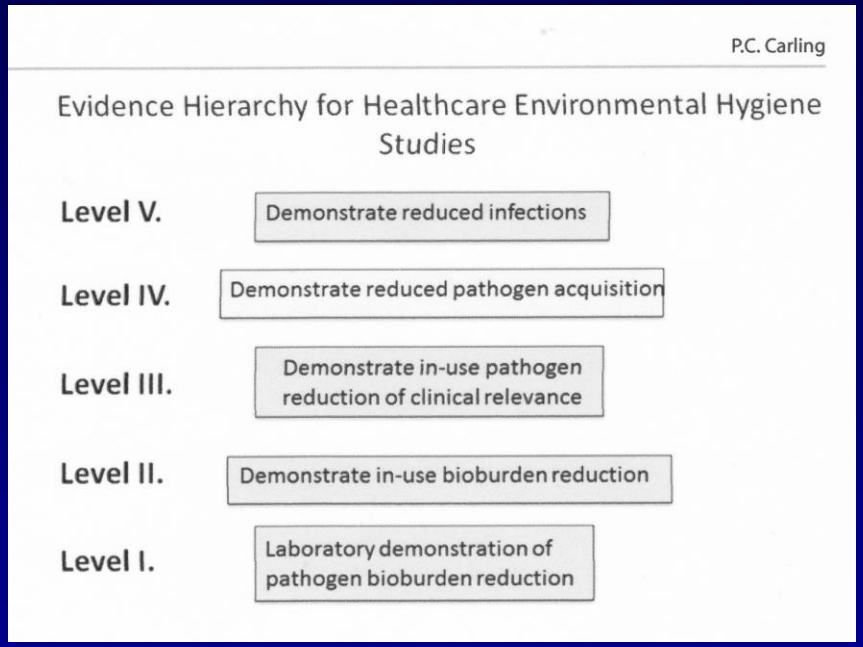


Table 8.7 Confounder evaluation pre-/post-intervention in 11 level V NTDT studies 2004–2016

Confounder	Objectively evaluated	Limited evaluation	Not evaluated
Changes in infection prevention interventions	7/11 (64%)	2/11 (18%)	2/11 (18%)
Compliance with planned intervention use	6/11 (55%)	3/11 (27%)	2/11 (18%)
Admission incidence density	3/11 (27%)		8/11 (73%)
Hand hygiene compliance	3/11 (27%)		8/11 (73%)
Isolation practice compliance	2/11 (18%)		9/11 (82%)
Thoroughness of disinfection cleaning	2/11 (18%)		9/11 (82%)
Antibiotic use trends	1/11 (9%)	2/11 (18%)	8/11 (73%)
Case mix	1/11 (9%)		10/11 (91%)



"…it is evident that further studies of these technologies will be needed before their role in HAI prevention can be objectively defined."

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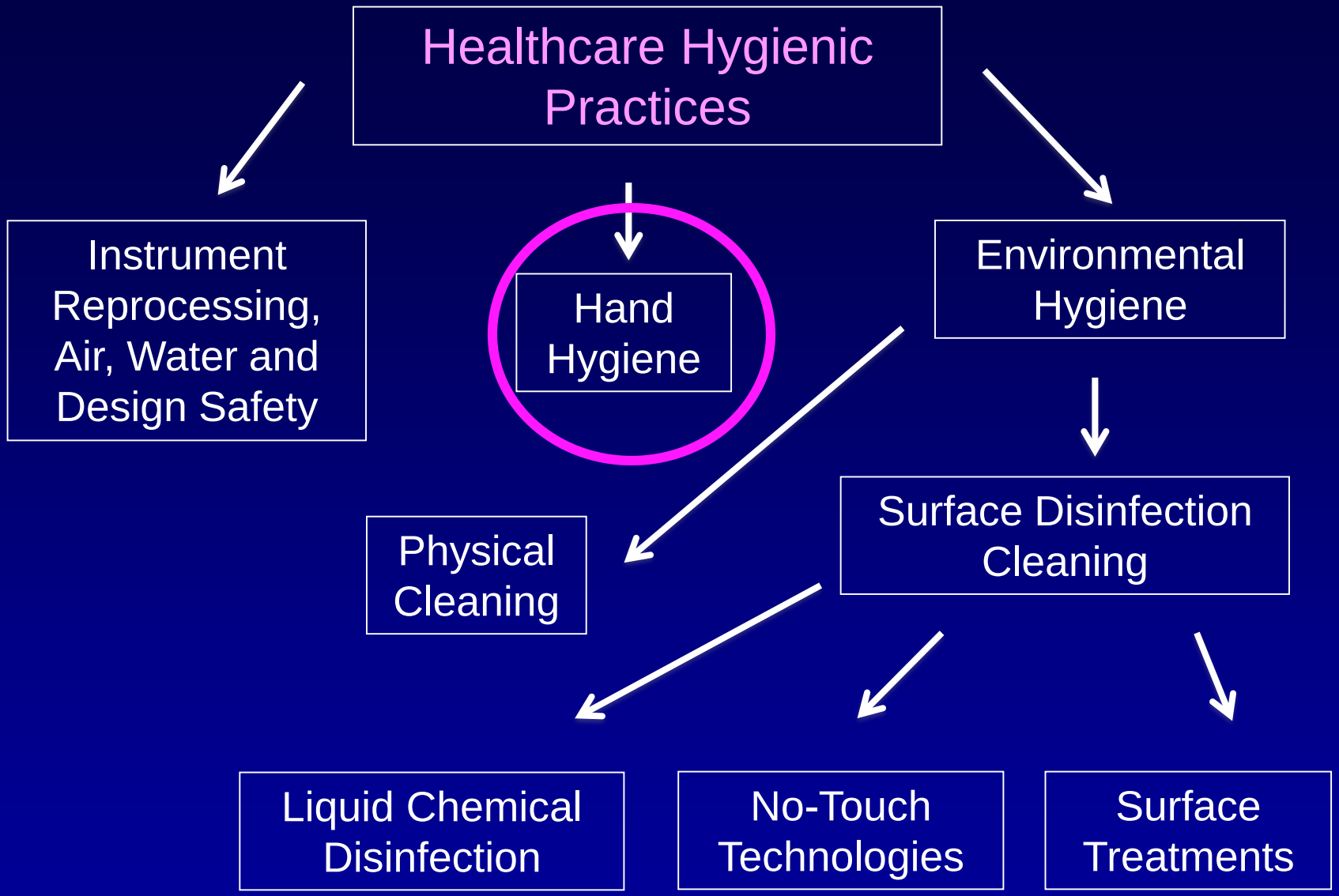
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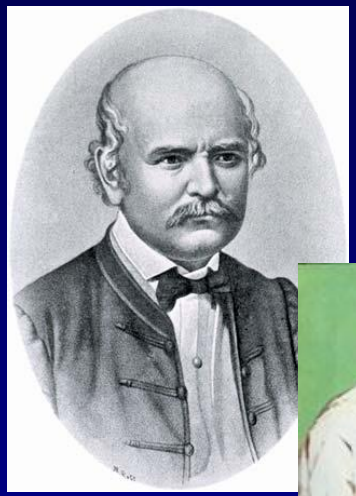
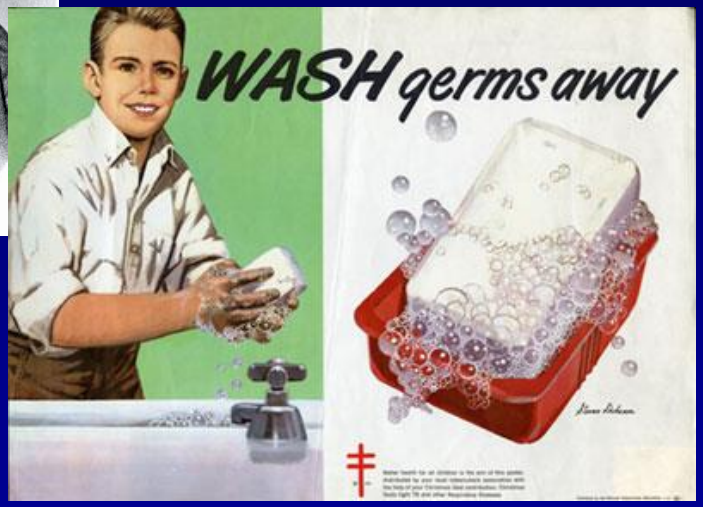
A brief history of hand hygiene





History of Hand Hygiene

"Infection control is in your hands."

Source: https://goo.gl/2HZRsQ

- The concept of "cleansing hands" emerged in the 19th century.
- Dr. Ignaz Semmelweis (1846) observed a significant reduction of infections as midwives cleaned their hands before and after dealing with patients.
- Thanks to Semmelweis' observations, The Centers for Disease Control and Prevention says *hand hygiene is one of the most important tools to preserve public health*.
- Encourage your employees and customers to wash their hands regularly to prevent sickness.

Washing hands prevents disease and puts everyone else at ease.
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A Heroic Hospital Story

+

A NEW use for alcohol

+

World Health Organization

→

A spectacular impact on HAI prevention in resource challenged settings

Hand Hygiene Challenges

First….A question

Hand Hygiene Challenges

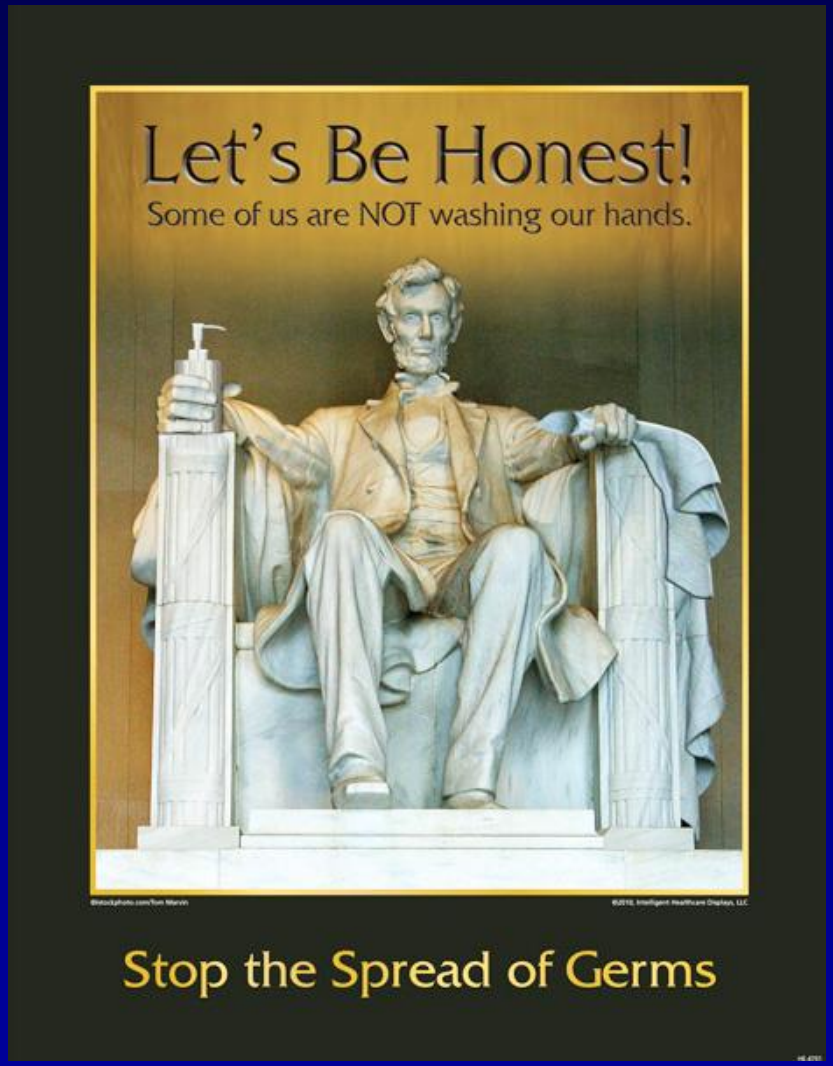
Has HH compliance in US hospitals during the past 15 years:

A. Improved a lot?

B. Improved a little?

C. Not really changed that much

There is no question that HH Compliance has improved in resource rich hospitals



If HH has improved in our acute care hospitals over the past 10 years, where is the benefit hiding?

Why doesn't hand hygiene work better?

The field of infection control is devoted to reducing the ... by midwives in the L

Conclusion:

"The time has come for the infection control community to move on…

We have to accept that our age-old dream of solving a complex problem cheaply and simply has failed.

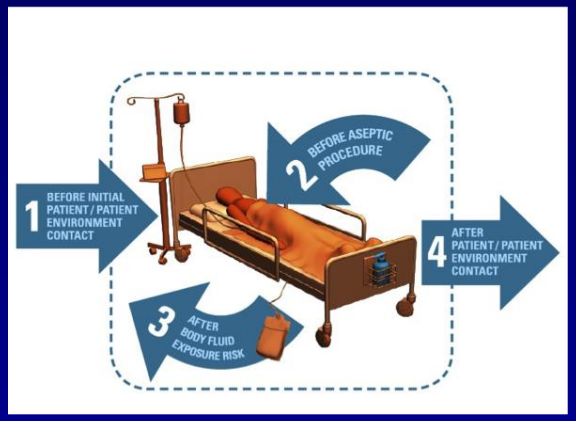
.

Sepkowicz KA. Lancet Infectious Diseases. 2012; 12: 97-99.

The three biggest Challenges to HH compliance in resource rich settings

1. Currently, accurate objective compliance monitoring is a quagmire

- Physical logistics are daunting



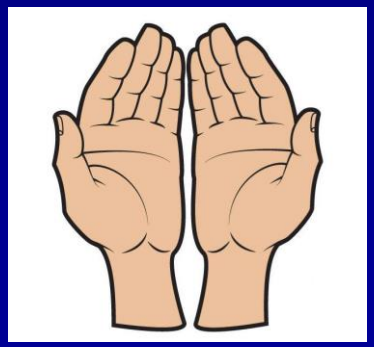
- Hawthorne Effect is pervasive
- Poor results are not managed well

2. The focus on HH before and after touching the patient

Multiple studies of asymptomatic carriers (C. diff, MRSA, VRE, Resistant GNBs) have shown:

The risk of hand acquisition is

=



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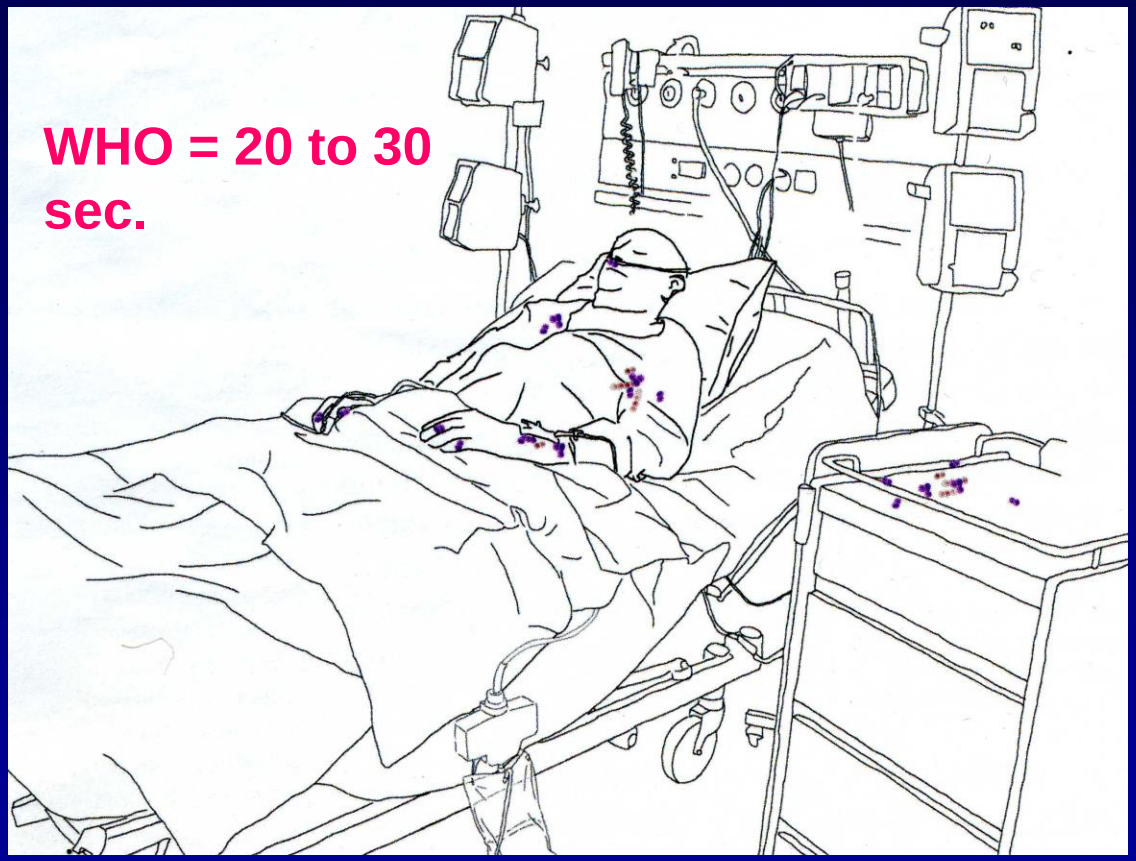
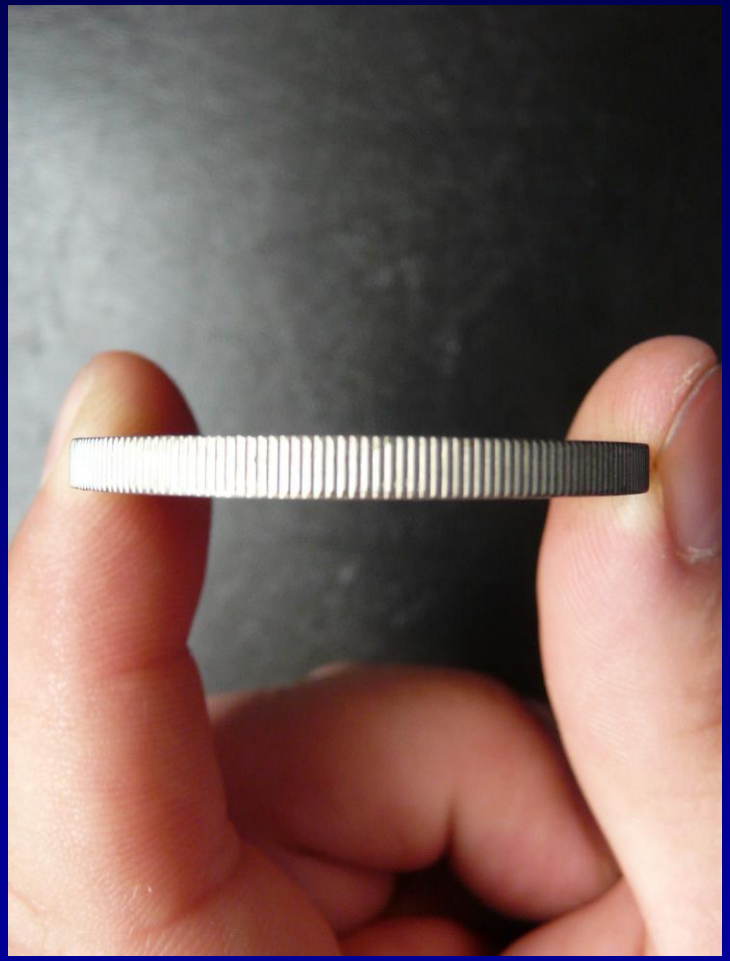
3. HH in Complex Intense Environments is Very Difficult



30 to 40 HH “Moments” per Hour during direct patient care

Is there a better approach?

I believe that HH and EH represent:



Two sides of the same coin which need to be optimized together to achieve the greatest impact on HAI prevention and HCW safety

The Hygienic Practice Continuum

Greater Challenge to Hand Hygiene

Transplant Unit

General ICU

Stronger Environmental Hygiene Mandate

Emergency Room

General Patient Rooms

Operating Room

Long-term Care Patient Rooms

Ambulatory Healthcare Settings

Day Care Changing Tables

Surfaces in Schools

Basic Environmental Hygiene Mandate

Public toilets

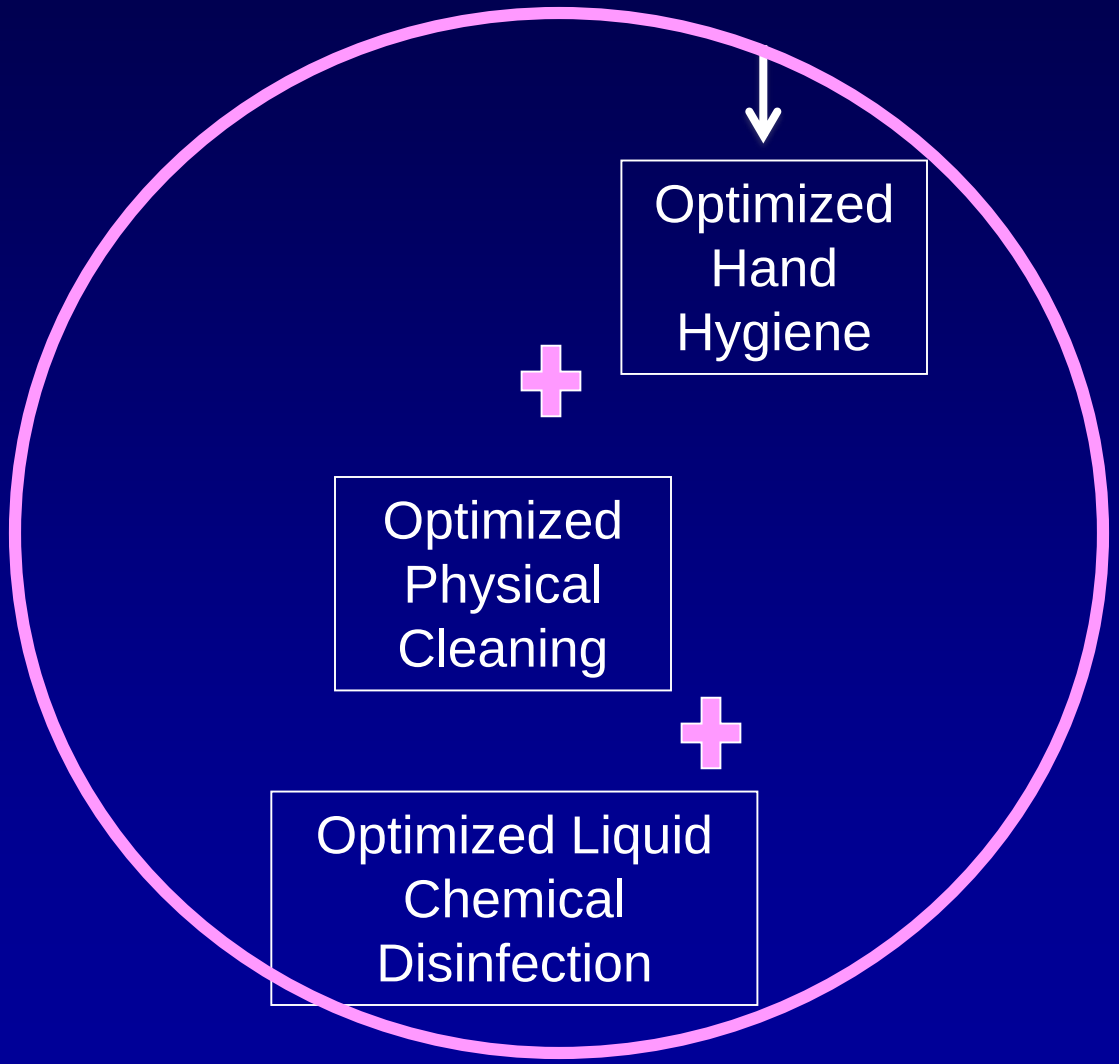
Home Food Preparation

Home Bathrooms

Less Challenge to Hand Hygiene

Carling PC. Optimizing Healthcare Environmental Hygiene.
Infect Dis Clin N Am. 30 (2016) 639-660.

Healthcare Hygienic Practice



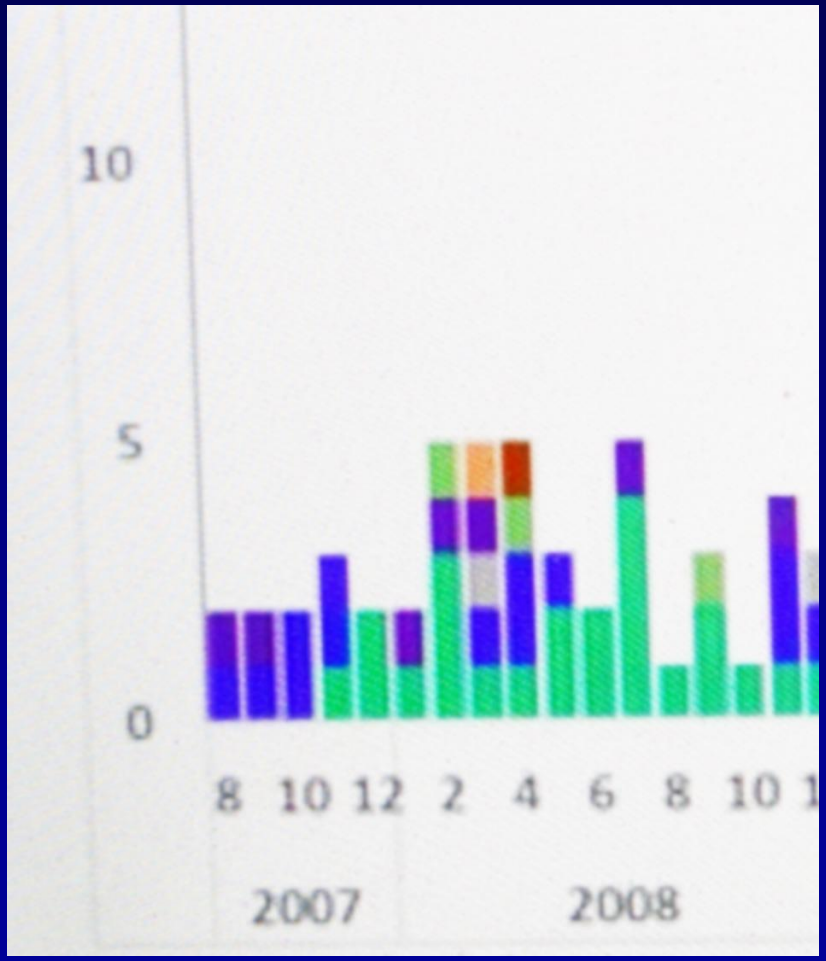
The next big challenge in HAI prevention?

SAGA

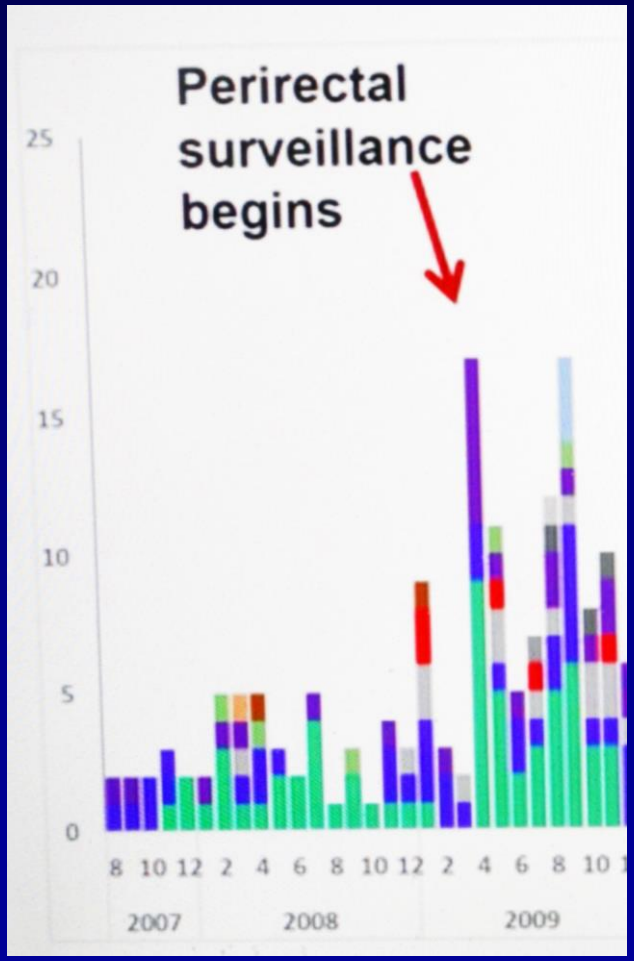
How I might define a Saga

- A story of a Hero or Heroes moving through a bad situation
- Perseverance despite setbacks
- Typically involves attempting to overcome a difficult to define or recognize antagonist
- Often an open ended story

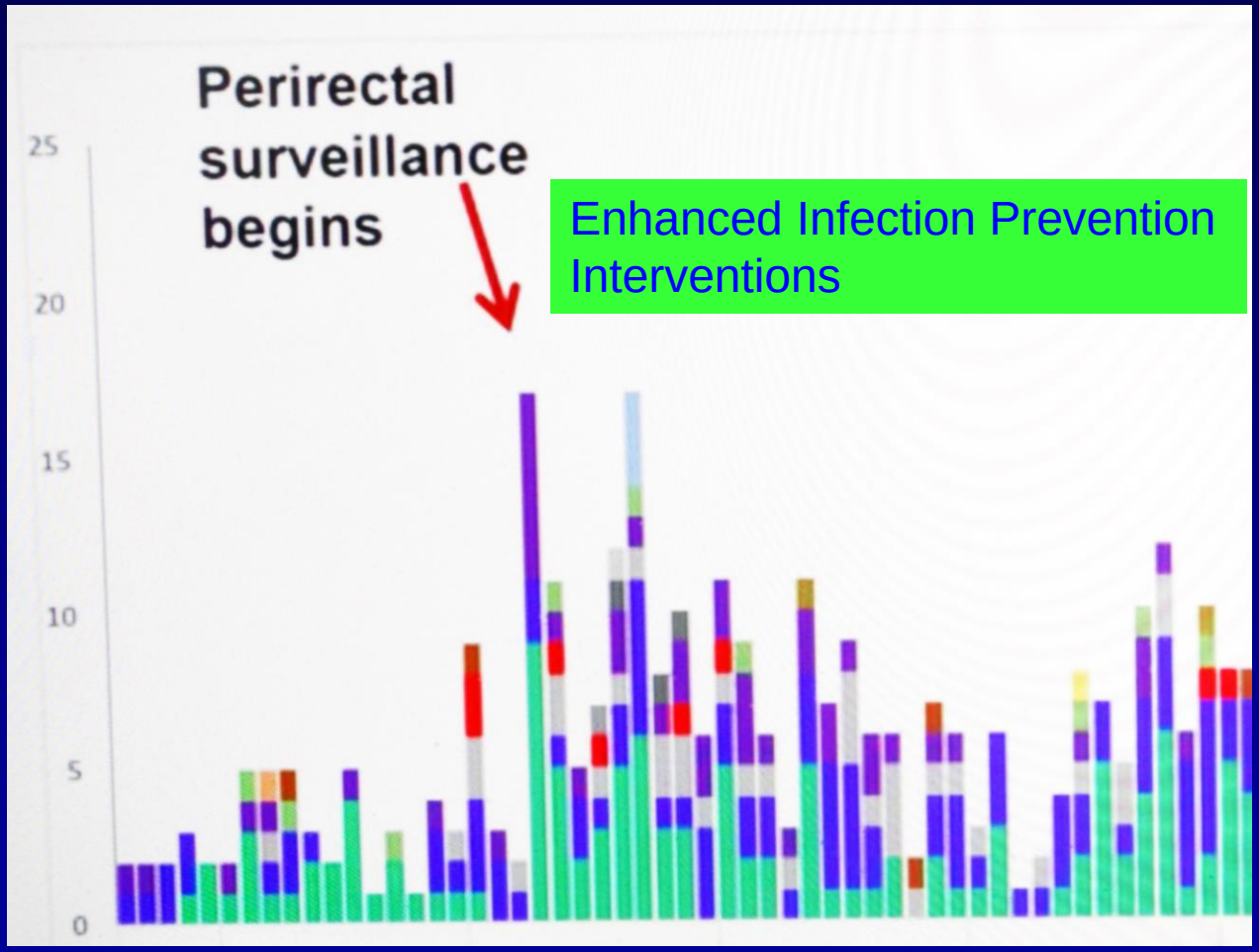
The University of Virginia Saga



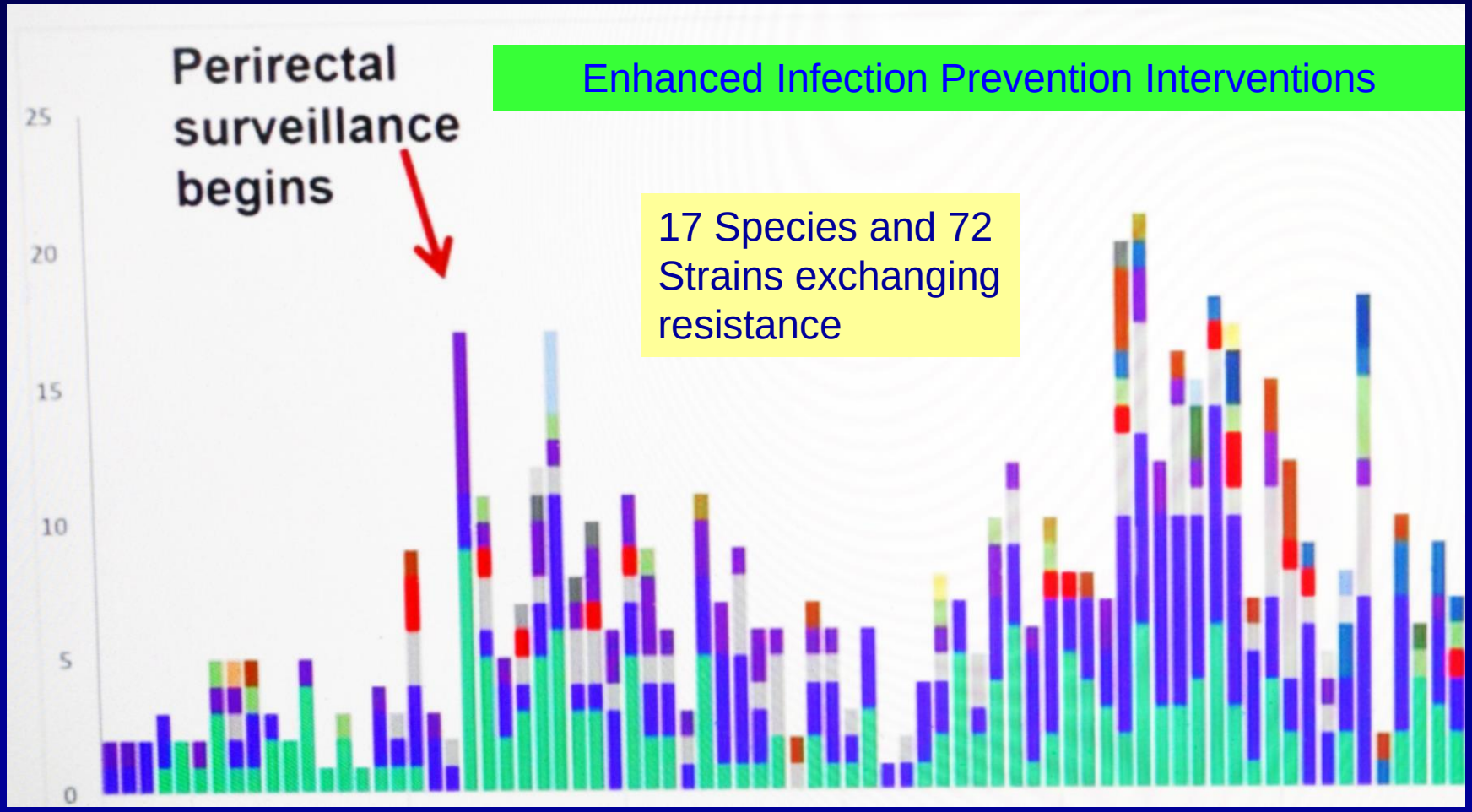
The University of Virginia Saga



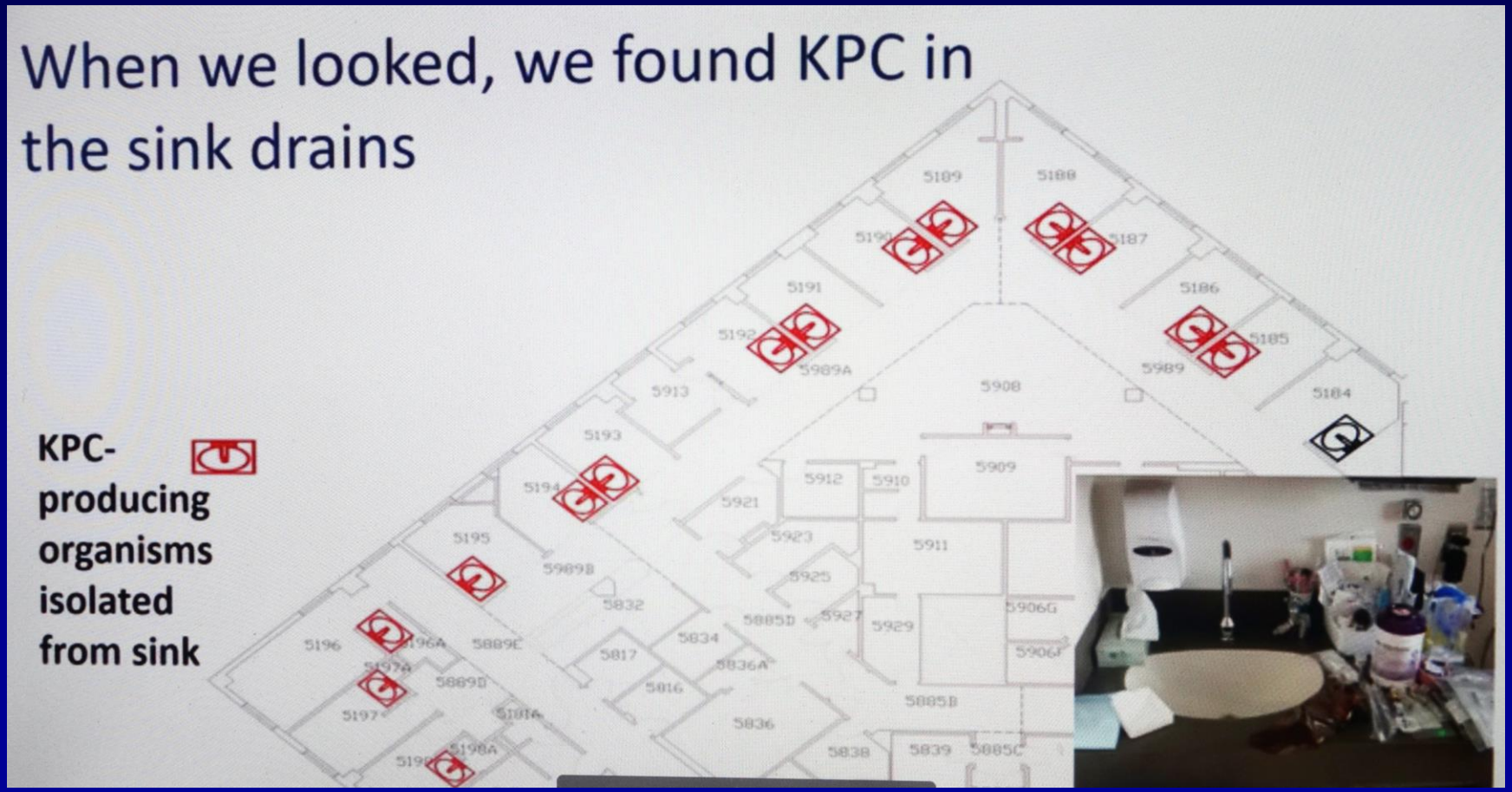
The University of Virginia Saga



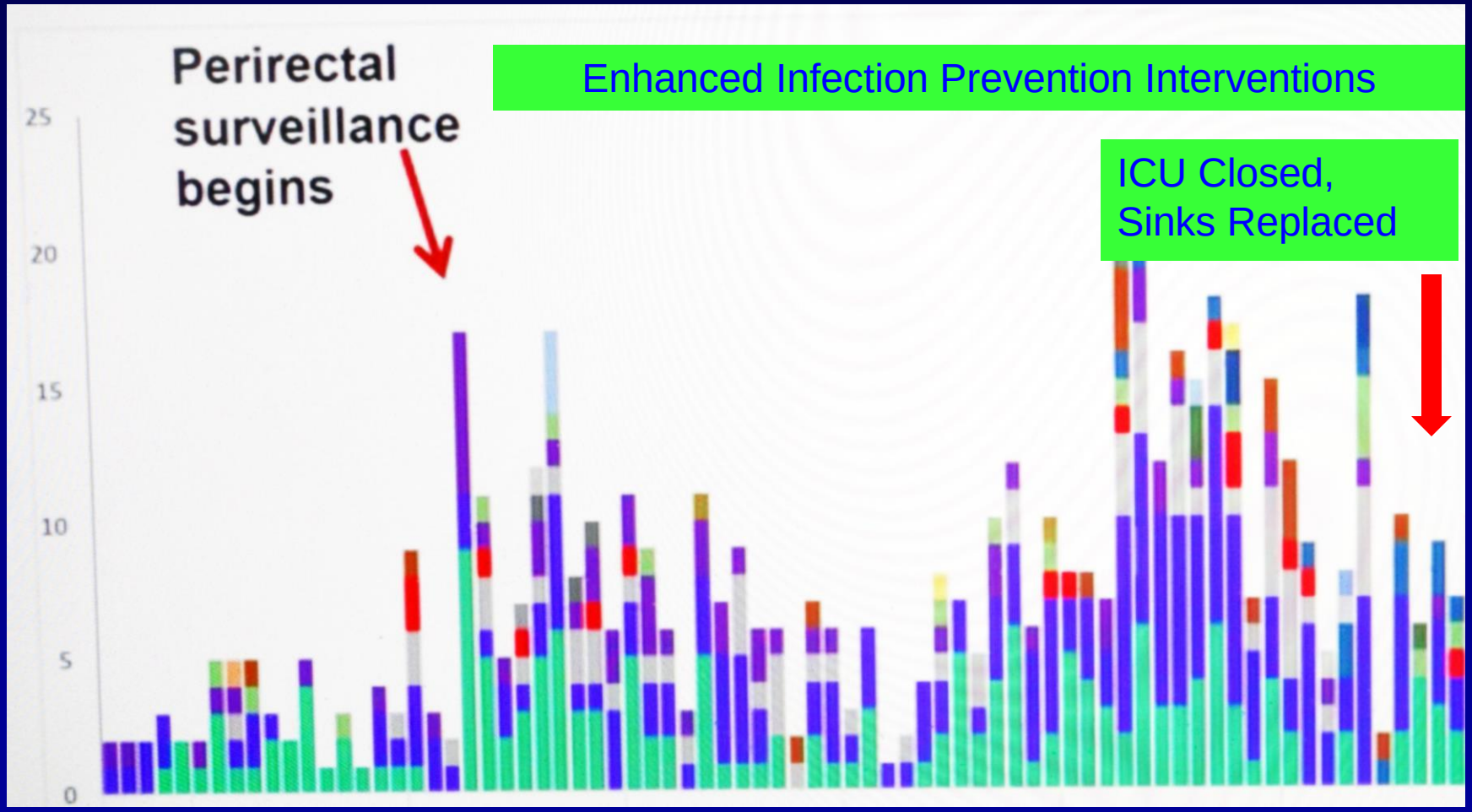
The University of Virginia Saga



The University of Virginia Saga



The University of Virginia Saga



The University of Virginia Saga

- Interventions:

  Sinks replaced

  Bleach “treatment”

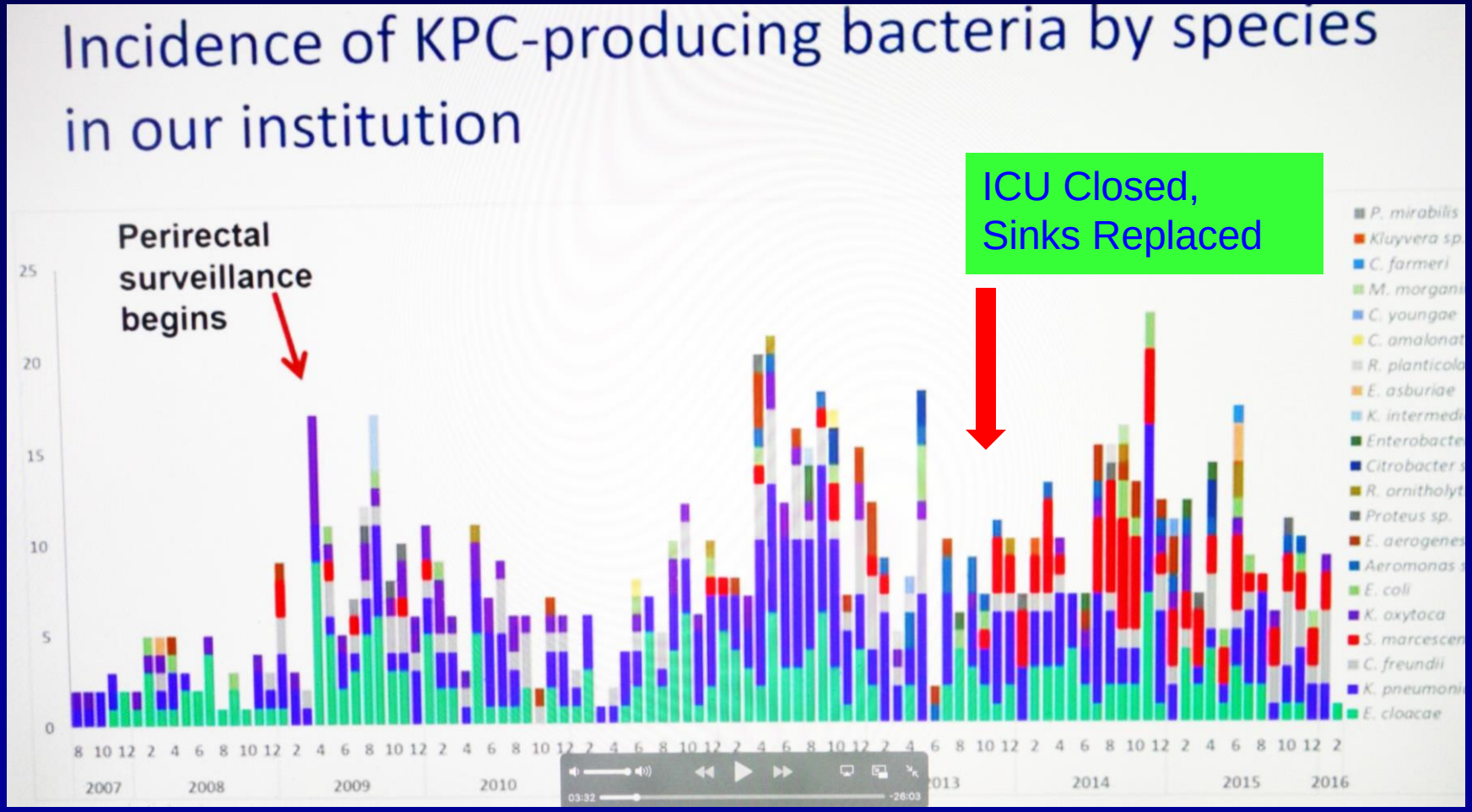
  Hydrogen peroxide “treatment”

  Ozone water “treatment”

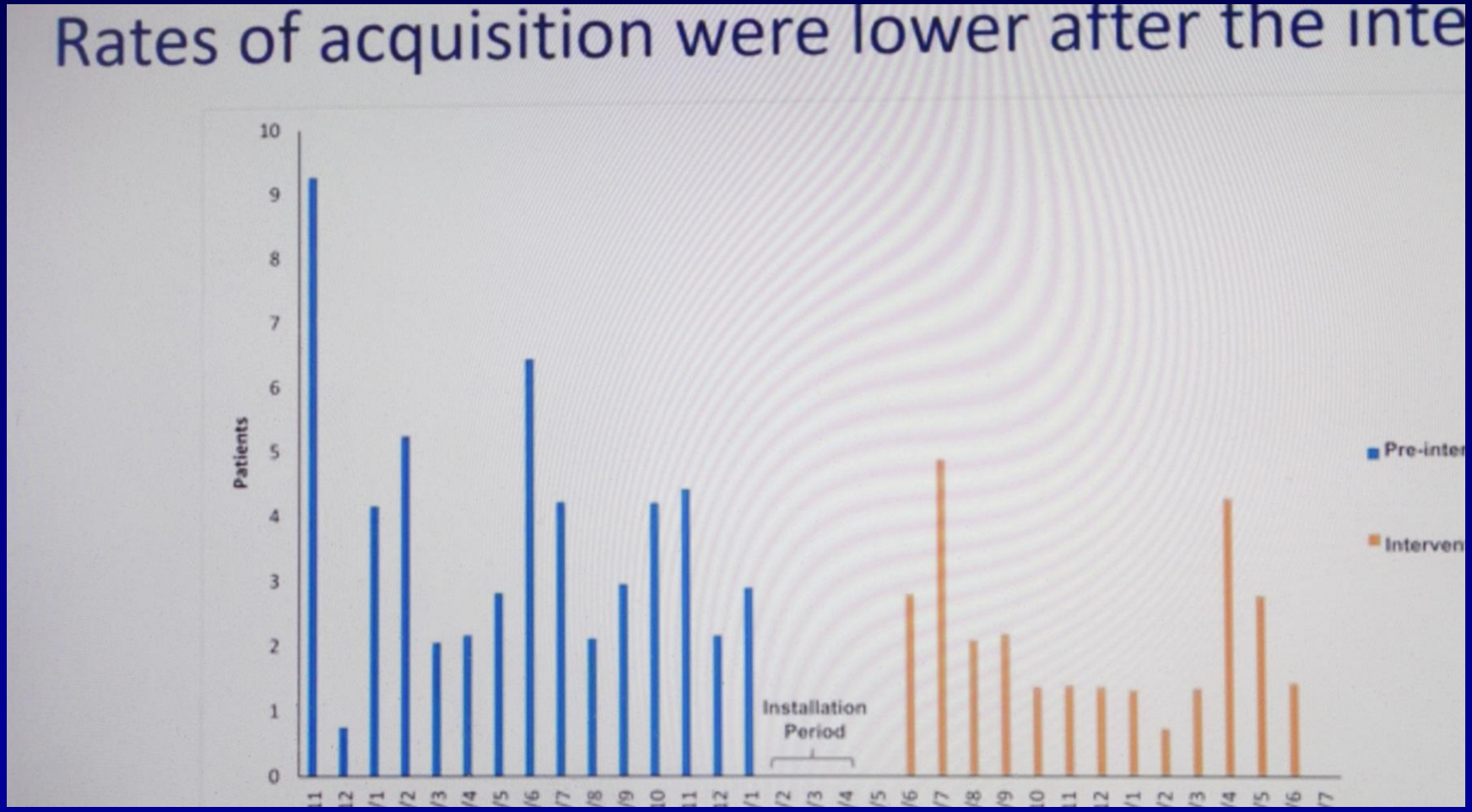
  Bed pan hoppers covered

  Some drain heater units

The University of Virginia Saga



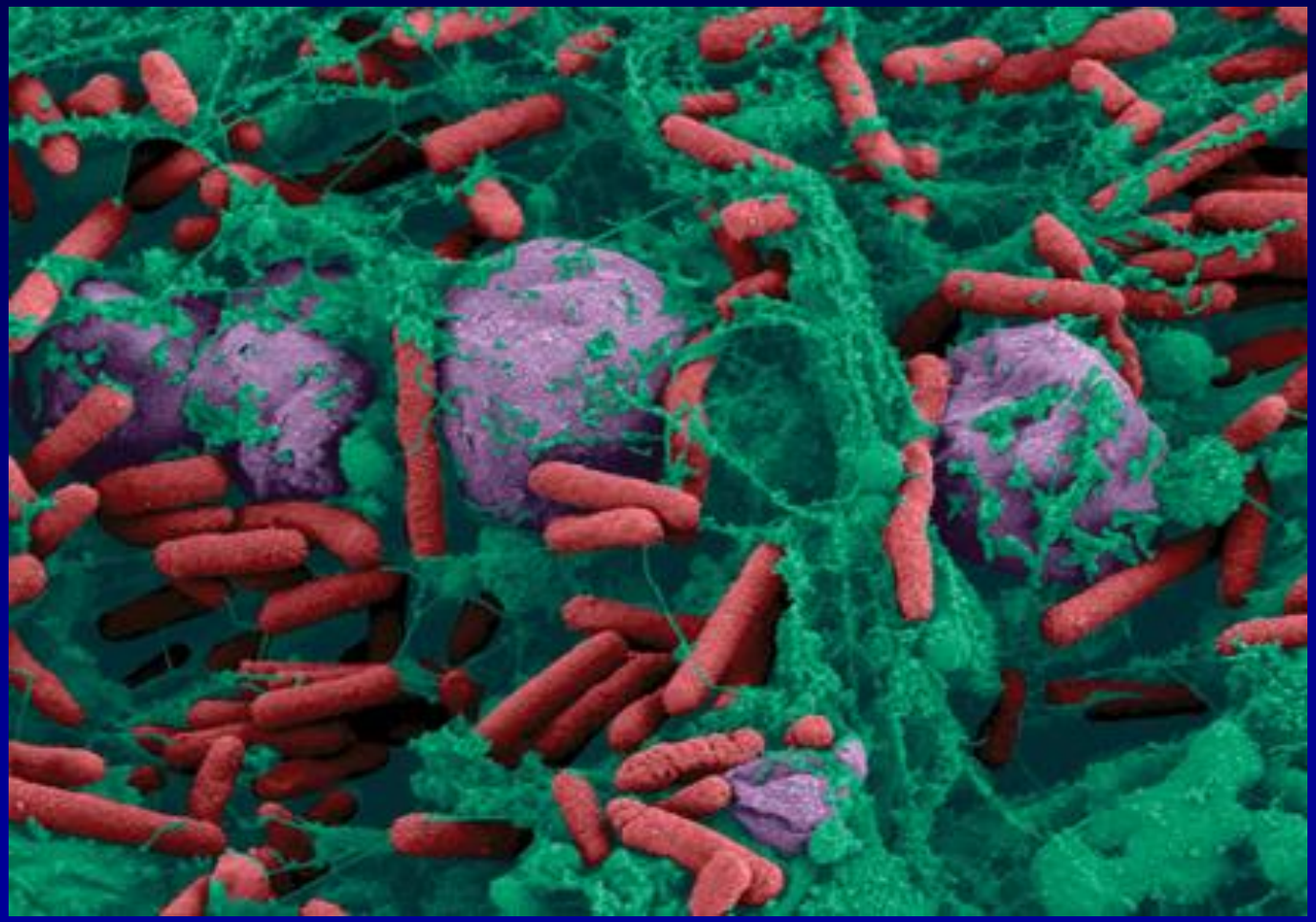
The University of Virginia Saga



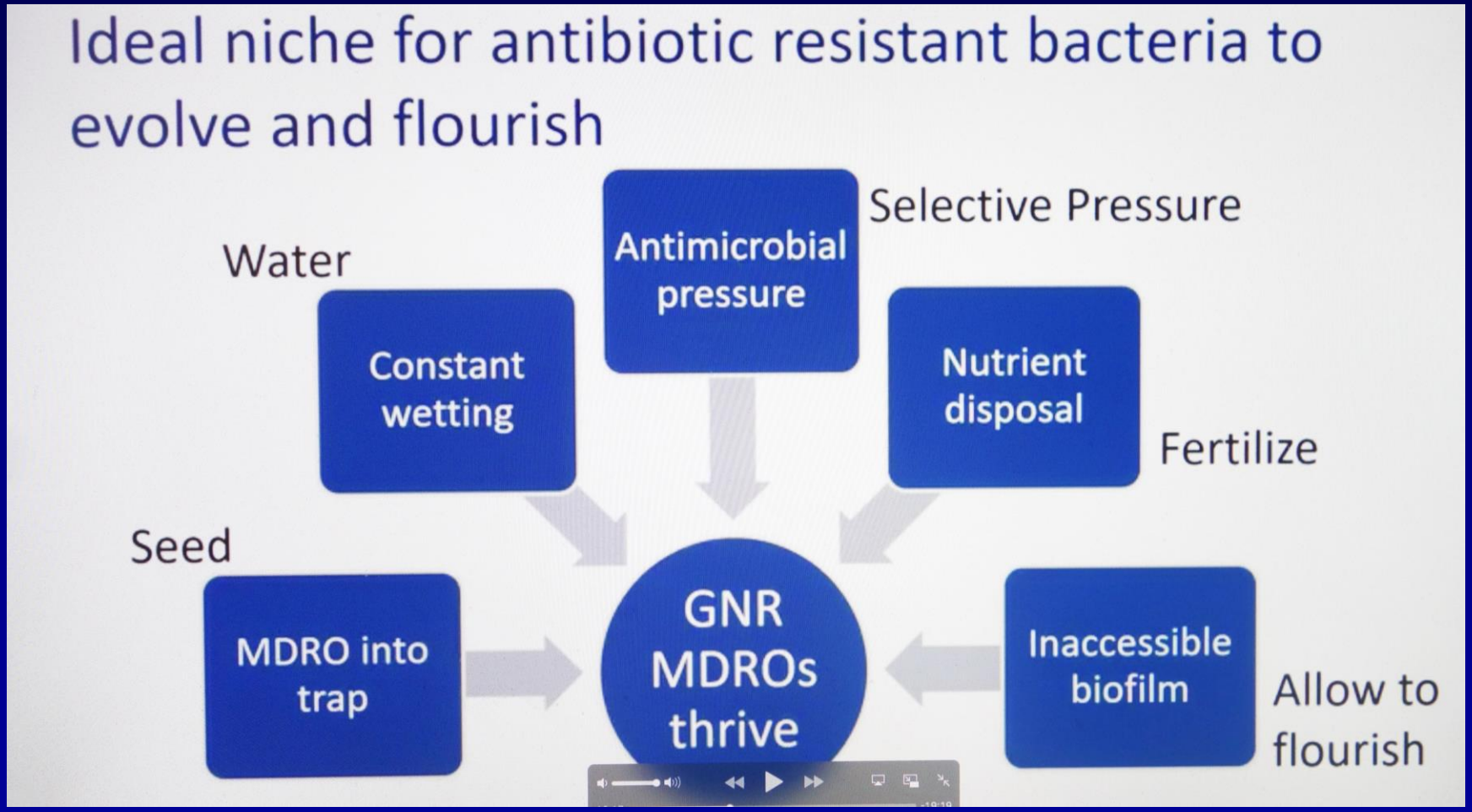
Mathers – 10/17

Why were wastewater drains an ongoing source of MDR-GNB colonization and infection??

The reason the trap is only a small part of the issue



The University of Virginia Saga



If numerous studies over the past 5 years have confirmed sinks as the source of Bad GI Bug infections in patients……

How do the bacteria get into the environment?

Applied and Environmental Microbiology

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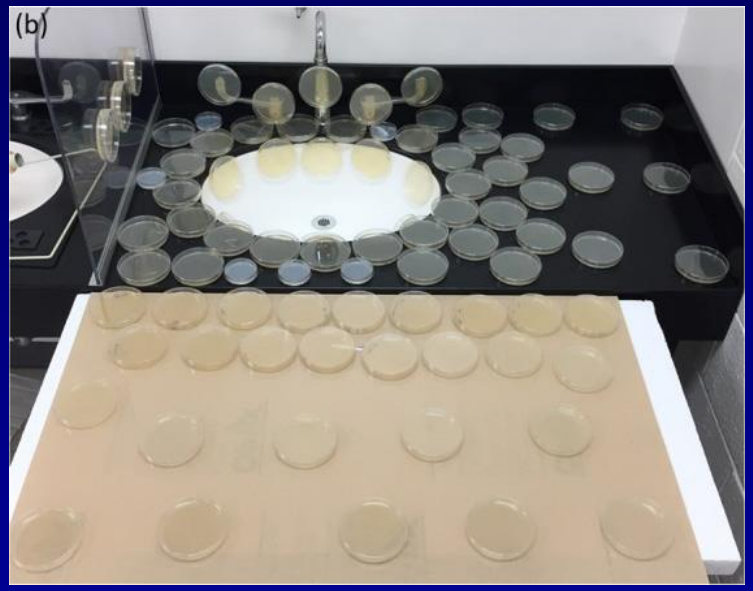
Spread from the Sink to the Patient: *In Situ* Study to Model Bacterial Dispersion from Hand-Washing Sink-Trap Reservoirs

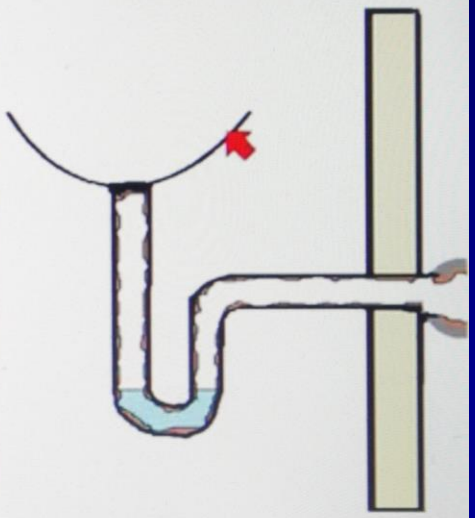


Because of this study we now know that simply running water into a contaminated sink spreads bacteria to the surrounding surface environment

March 2017

The University of Virginia Saga

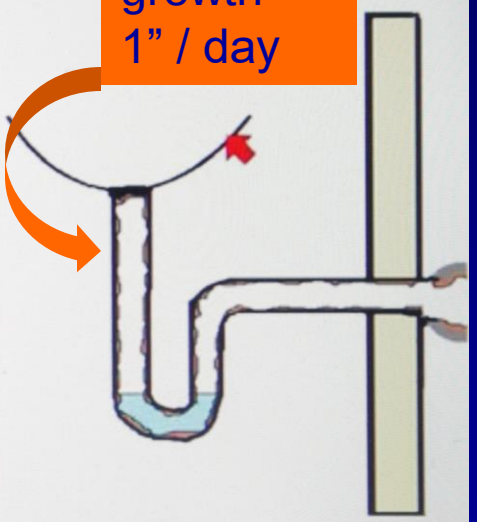
Biofilm had to establish in the drain



Growth continued along wastewater connections from sink

The University of Virginia Saga

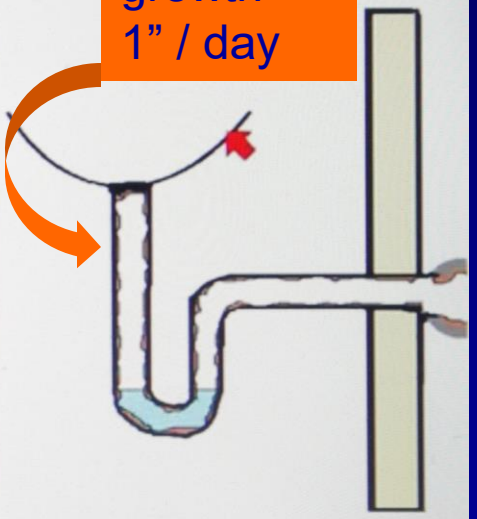
Biofilm had to establish in the drain



Growth continued along wastewater connections from sink

The University of Virginia Saga

Biofilm had to establish in the drain



Growth continued along wastewater connections from sink

Infection Control & Hospital Epidemiology (2018), **0**, 1–8
doi:10.1017/ice.2018.138

SHEA
The Society for Healthcare Epidemiology of America

Review

Wastewater drains: epidemiology and interventions in 23 carbapenem-resistant organism outbreaks

Philip C. Carling MD, FSHEA[1,2]
[1]Infectious Diseases Section, Steward Carney Hospital, Boston, Massachusetts and [2]Boston University School of Medicine, Boston, Massachusetts

- Conclusions:
- WWD Biofilm provides an ideal environment for genetic exchange of drug resistance.
- All disinfection protocols were without clear benefit.
- Sink replacement fails due to biofilm regrowth
- “Use great caution before culturing WWD” (A Mathers)

Sink traps, hopper covers and bad bugs

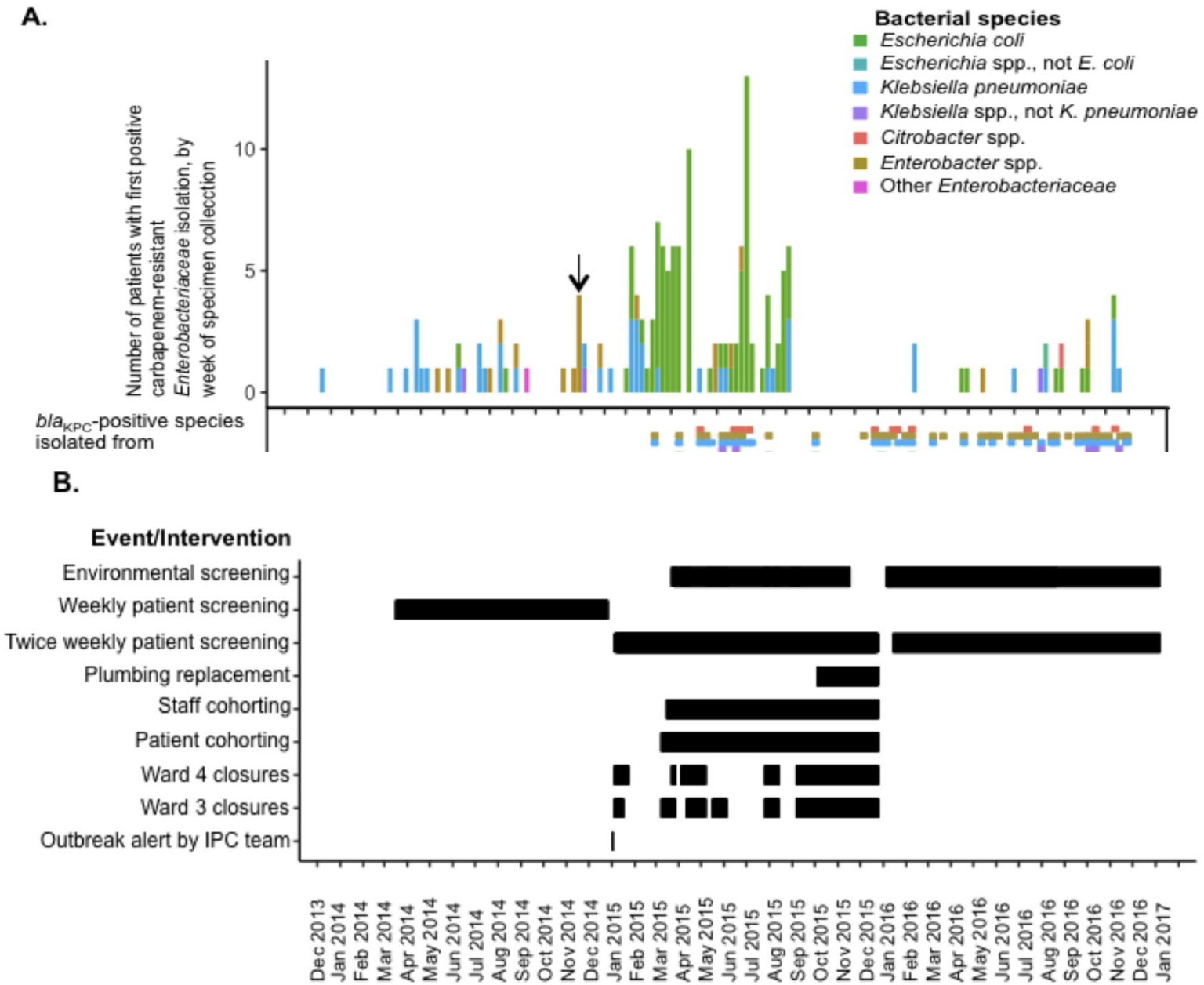
Tara Palmore, M.D.
Hospital Epidemiologist
NIH Clinical Center
National Institutes of Health
April 25, 2019

NIH National Institutes of Health
Turning Discovery Into Health

AMERICAN SOCIETY FOR MICROBIOLOGY | Antimicrobial Agents and Chemotherapy®

A Large, Refractory Nosocomial Outbreak of *Klebsiella pneumoniae* Carbapenemase-Producing *Escherichia coli* Demonstrates Carbapenemase Gene Outbreaks Involving Sink Sites Require Novel Approaches to Infection Control

V. Decraene,[a] H. T. T. Phan,[b,c] R. George,[d] D. H. Wyllie,[b,c] O. Akinremi,[c,e] Z. Aiken,[d] P. Cleary,[a] A. Dodgson,[b,f] L. Pankhurst,[b,c] D. W. Crook,[b,c,e] C. Lenney,[d] A. S. Walker,[b,c] N. Woodford,[c,e] R. Sebra,[g] F. Fath-Ordoubadi,[d] A. J. Mathers,[h,i] A. C. Seale,[j,k] M. Guiver,[f] A. McEwan,[d] V. Watts,[a] W. Welfare,[l,m] N. Stoesser,[b,c] J. Cawthorne,[d] the TRACE Investigators' Group


A.
Bacterial species
Escherichia coli
Escherichia spp., not E. coli
Klebsiella pneumoniae
Klebsiella spp., not K. pneumoniae
Citrobacter spp.
Enterobacter spp.
Other Enterobacteriaceae
Number of patients with first positive carbapenem-resistant Enterobacteriaceae isolation, by week of specimen collection
10
5
0
blaKPC-positive species isolated from
B.
Event/Intervention
Environmental screening
Weekly patient screening
Twice weekly patient screening
Plumbing replacement
Staff cohorting
Patient cohorting
Ward 4 closures
Ward 3 closures
Outbreak alert by IPC team
Dec 2013
Jan 2014
Feb 2014
Mar 2014
Apr 2014
May 2014
Jun 2014
Jul 2014
Aug 2014
Sep 2014
Oct 2014
Nov 2014
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Jan 2015
Feb 2015
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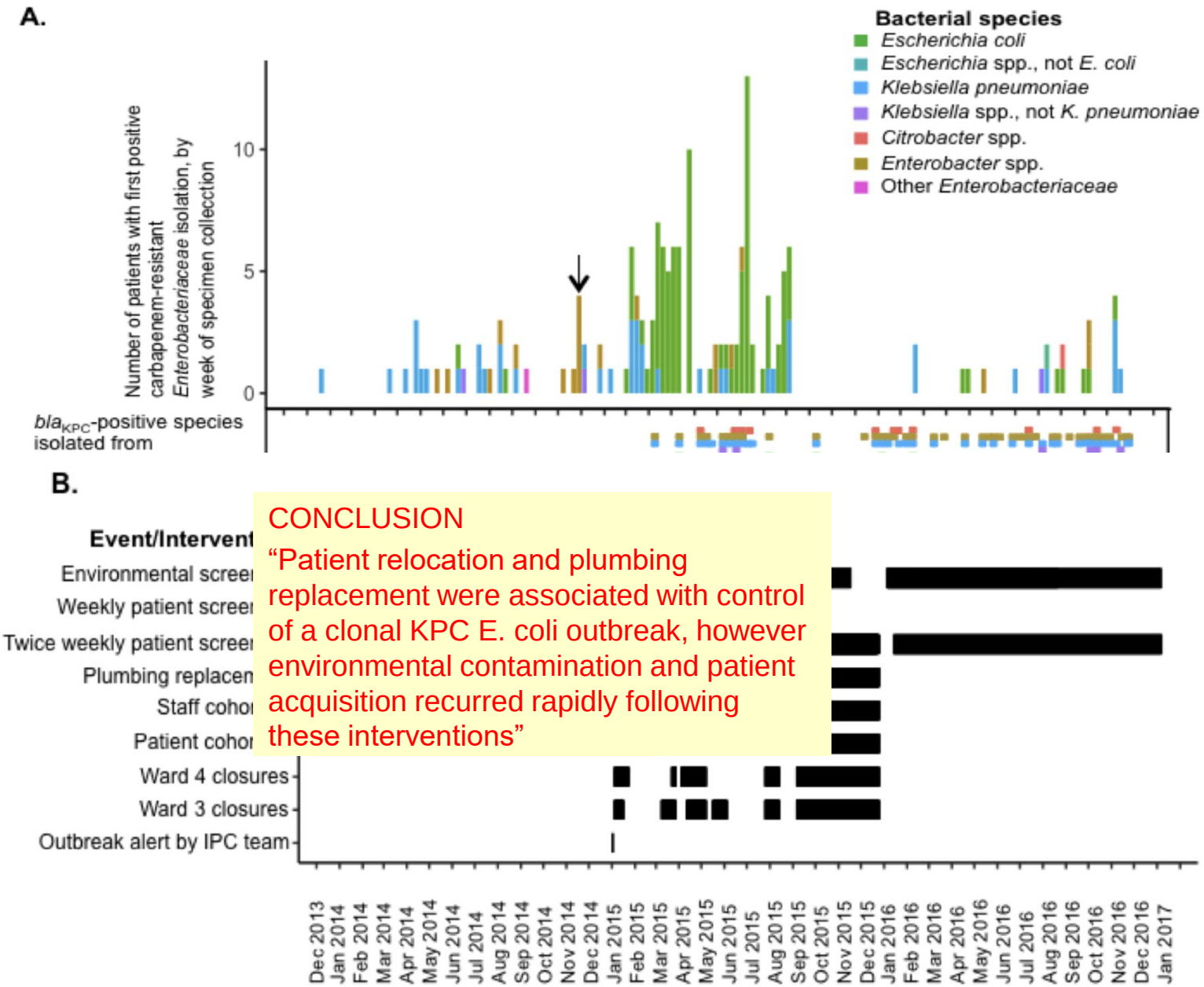
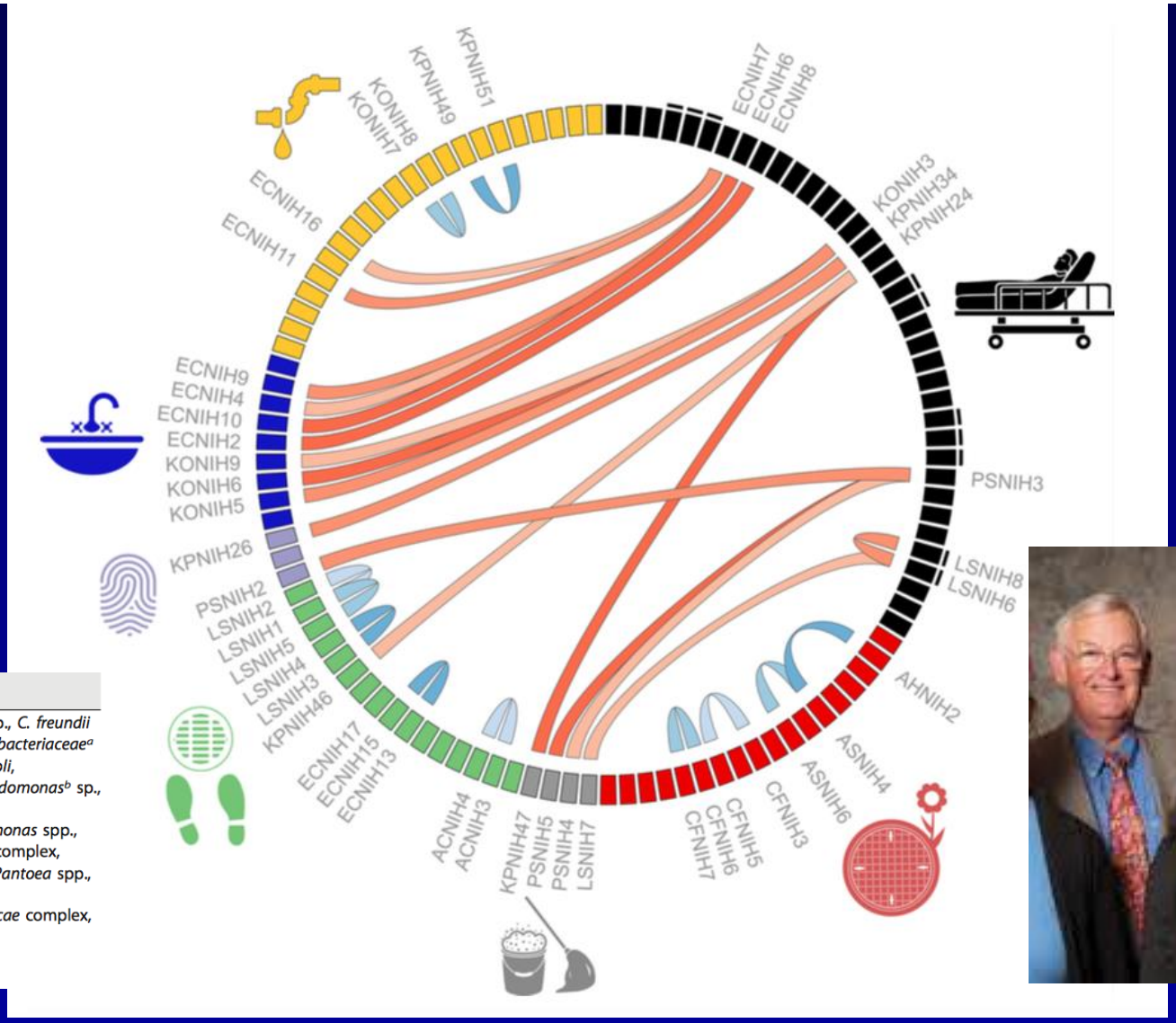
Jan 2017



CONCLUSION

"Patient relocation and plumbing replacement were associated with control of a clonal KPC E. coli outbreak, however environmental contamination and patient acquisition recurred rapidly following these interventions"

Genomic Analysis of Hospital Plumbing Reveals Diverse Reservoir of Bacterial Plasmids Conferring Carbapenem Resistance



Species identified

Acinetobacter spp., *Aeromonas* spp., *C. freundii* complex, *Citrobacter* sp., *Enterobacteriaceae*[a] family, *E. cloacae* complex, *E. coli*, *K. pneumoniae*, *K. oxytoca*, *Pseudomonas*[b] sp., *Serratia*[c] spp.

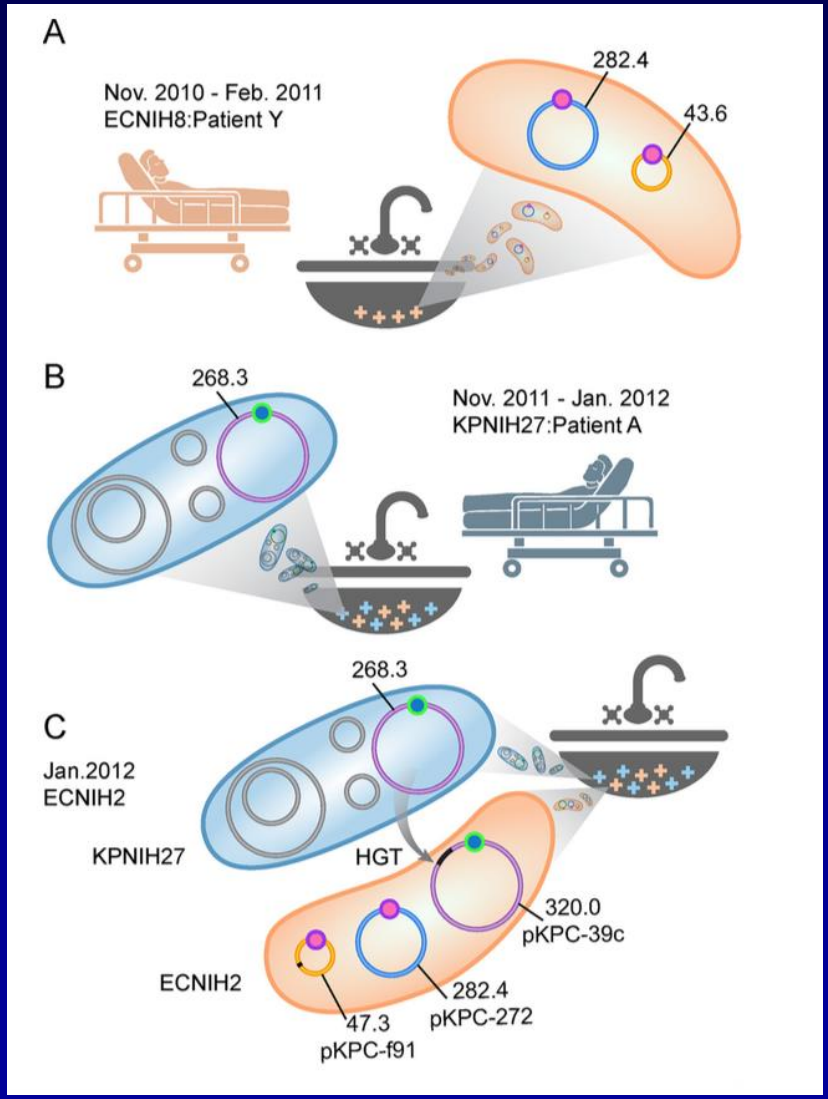
Acinetobacter spp. (bla_{NDM}), *Aeromonas* spp., *C. freundii* complex, *E. cloacae* complex, *Leclercia* spp., *Escherichia*[d] sp., *Pantoea* spp., *K. pneumoniae*

K. pneumoniae, *K. oxytoca*, *E. cloacae* complex, *C. freundii* complex, *Pantoea* spp., *K. pneumoniae*

Aside from transmission of CROs to patients there is a second layer of concern related to WWDs

Genomic Analysis of Hospital Plumbing Reveals Diverse Reservoir of Bacterial Plasmids Conferring Carbapenem Resistance

NIH – January 2018



Conclusions

- Drains, toilets and other wastewater reservoirs are documented sources of direct or indirect transmission of MDROs to patients.
- Optimizing hygiene practices, environmental cleaning, and infection control measures is necessary but not sufficient.
- Innovative yet feasible, cost-effective, and scalable solutions are needed for this patient safety problem.

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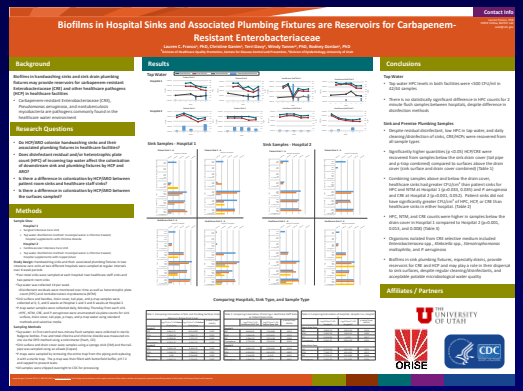
Droplet- Rather than Aerosol-Mediated Dispersion Is the Primary Mechanism of Bacterial Transmission from Contaminated Hand-Washing Sink Traps

IMPORTANCE Among the possible environmental reservoirs in a patient care environment, sink drains are increasingly recognized as a potential reservoir to hospitalized patients of multidrug-resistant health care-associated pathogens.

APRIL 25, 2019

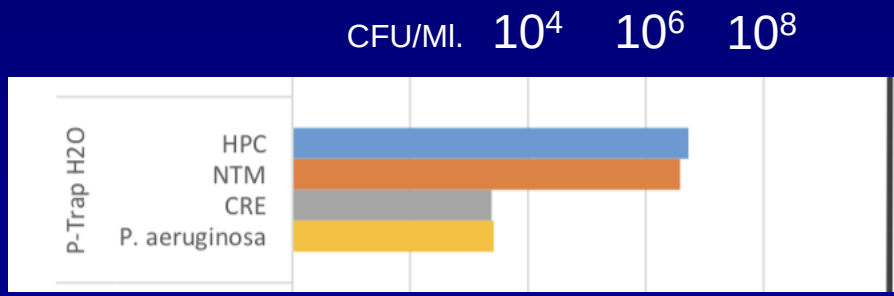
CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

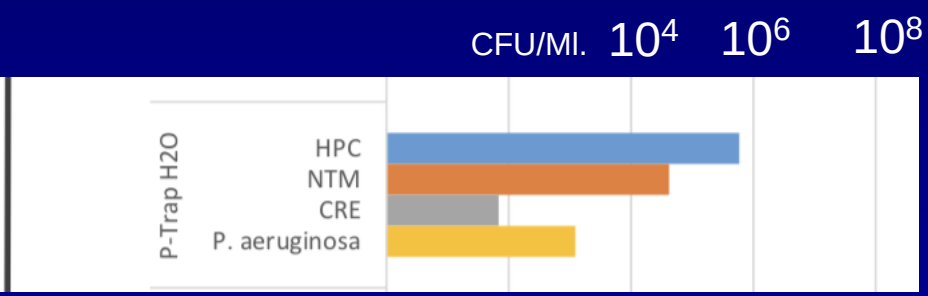
Biofilms in Hospital Sinks and Associated Plumbing Fixtures are Reservoirs for Carbapenem-Resistant Enterobacteriaceae

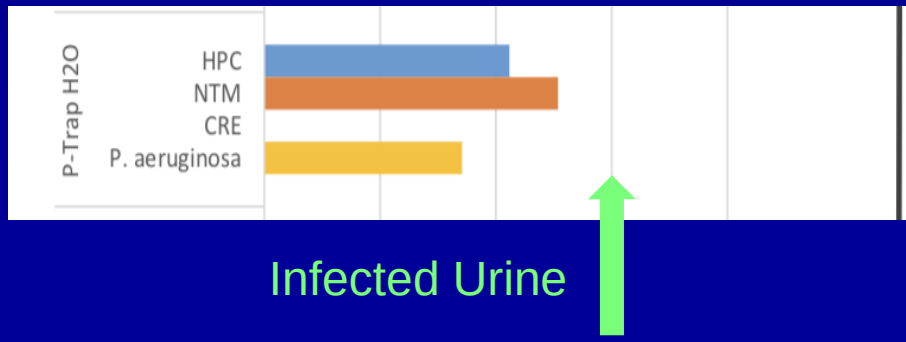


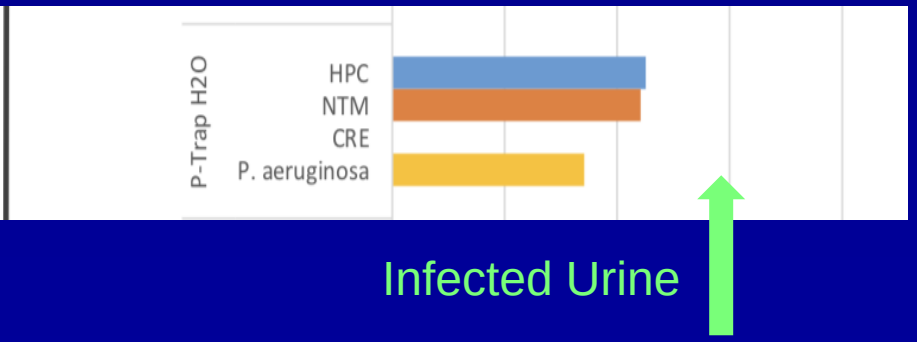
Quantitative analysis of P-pipe water contamination is 8 sinks in 2 Hospitals in Utah

SHEA April 2019









So where do we go from here?

Thank you!

Questions Comments? Philip.Carling.MD@steward.org